CHEMISTRY IN OLD PHILADELPHIA

EDGAR F. SMITH

1919

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CHEMISTRY
IN
OLD PHILADELPHIA

BY

EDGAR F. SMITH

UNIVERSITY OF PENNSYLVANIA

"These are deeds which should not pass away,
And names that must not wither . . . . "

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CHEMISTRY IN OLD PHILADELPHIA

"Oh! dear is a tale of Olden Time"

And I am glad to tell of "Chemistry in Old Philadelphia" as I found it in ancient volumes, musty documents and seared and forgotten letters;

In the period when Pennsylvania was a Province;

In the good old days when every house in the City had its doorporch, occupied generally by families in repose and social intercourse, or by youth who there "vied in telling strange, incredible stories," and in singing ballads—favorites of the day—which disclosed to the passer-by many fine, rich melodious voices;

In the days when it was thought an "effeminacy in men to be seen cleaning the teeth at all, the genteelest being content to rub them with a chalked rag or with snuff";

When the voice of the devout and ardent Whitefield rang out clear as a bell on renowned High Street, calling sinners to their knees, and was plainly heard upon "Society Hill," and on the eastern shores of the swiftly flowing and majestic Delaware;

When night watchmen repressed nightly insults;

When the Old State House, venerable pile, consecrated by numerous deeds in our colonial and revolutionary history, was the attractive center of high and low, because there the representatives of a nation resolved to be free and independent, and its sacred bell rang out—

"Proclaim liberty throughout the land, and to all the people thereof";

In the days when a single structure, humble—alone, stood in the field across the way, bearing on its shield the legend—*State House Inn,* the scene of many a fierce political struggle, or famous banquet, continued midst song and click of glass to morning dawn; where ruled supreme the despotic Norah, "passing fair," who drew after her the Oglebys of the day;

When the prose, the poetry and the pranks of a Hopkinson, the puns of a Pennington, and the pungent probes of a Pemberton, presented proofs of the pleasantry of that period to which times since past were perfect strangers;

When in the opening years of the young Republic there was an impolitic and extravagant affection for fair France, in that lads on the streets donned the National Cockade and saluted French Marines and officers with, "Vive la Republique," "Allons enfans de la patrie, le jour de gloire est arrive," etc.;

When the Mansion House, on South Third Street, was frequented by the élite, and by such distinguished guests as Madame Iturbide, wife of Mexico's Emperor, and her family;

When Lafayette occupied the east wing of Independence Hall as his reception room; but

"While we thus retrace with memory's pointing wand,
That calls the past to our exact review"——

I am reminded that in colonial days, and in the early years of the Republic, there were chemists in the City of Brotherly Love. To a few of them let me introduce you.

First, to Dr. de Normandie. While probably more of a physician, yet he was a lover of chemistry as it then existed. My chief purpose in presenting him is that from his pen came the first chemical contribution which appeared in print in this country, at least the first to find its way into the pages of the first volume of the "Transactions of the American Philosophical Society." It bears the date 1768. It treats of the chemical nature of water brought from a spring at Bristol, Pa. To chemists this contribution appeals because from it one may gather ideas regarding the knowledge of chemical analysis prevailing at that early period. The methods employed to detect iron, calcium, magnesium and the acid ions were most primitive. We marvel as we read, and unthinkingly ask how could such absurd things be expected to reveal anything; but pray be not so exacting. While crude and almost ridiculous, these same tests did disclose something in regard to the substances held in solution by the water, and this something was the iron, etc., the presence of which would be ascertained to-day by methods vastly different, and, in our judgment, vastly superior. So be it. But, de Normandie's work was chemical in character and demonstrates that the science was being used in the service of man—also to enrich his knowledge of nature. Another interesting feature of the work was that de Normandie used the balance. He weighed—away back in the year 1768! There is no means of learning anything about the character of the instrument employed by him. He is silent on that point, but for us the vital thing is that he used the balance. Many students of the history of chemistry, after trailing along through the circuitous paths pursued by the fathers of our science who were massing facts upon facts—will recall the thrill which surged through their whole being when on studying the epoch-making work of Lavoisier, the balance was held constantly before their eyes, when it was declared to be the arbiter of the fate of all theories and allied speculations. The fact that Lavoisier *weighed* seemed to overshadow everything else and also every chemist, with the consequence that we poor deluded ones chattered about his superiority over his colleagues. But now we know that even before Lavoisier, other chemists weighed—

used a balance—notably Jean Rey, whose experiments were truly fundamental in character; and, here in Philadelphia as early as 1768, John de Normandie *weighed*. His purpose was not to support or overthrow some contested theory, but to learn what was possible regarding the amounts of the things he had found in water by means of powdered chalk, crude sal ammoniac, white oak bark, linen, and the other reagents now seemingly so queer, in sound, at least, to our ears.

As to de Normandie's origin, his training, and as to other contributions from his pen, the annals of local history reveal naught. But this single published effort indicates that chemistry was beginning to draw attention to its value.

In the year (1769) following the appearance of de Normandie's contribution there was instituted at the University of Pennsylvania a chair of chemistry—unencumbered by and dissociated from any other branch of science—and Dr. Benjamin Rush (1745–1813), its incumbent, declares Benjamin Silliman, Jr., " was undoubtedly the first professor of chemistry in America, and as such his name must ever be entertained with respect." He was at heart a medical man. His degree in medicine was received at Edinburgh in 1768. Note the Scotch influence here as also in the case of his colleagues in the young faculty of medicine at the University. His knowledge of chemistry was derived almost exclusively from the eminently celebrated Joseph Black, whom he ever delighted to honor. Rush was preëminently great in many lines of inquiry. His writings are numerous. In the particular domain of chemical science his literary activity seems to have been limited to a single paper on the analysis of mineral waters, possessing medicinal properties. It is a brochure selling to-day in the stalls of booksellers for $13.50; its value doubtless being due to the fact that it emanated from the pen of its very distinguished author.

Scientifically it does not have the value of de Normandie's paper. However, from contemporaneous literature it is safe and fair to add that the "first professor of chemistry in America," while not making any original contributions in the way of investigation, yet taugh his science after the spirit of his Scotch master. Judging from the latter's text-book, it may be believed that Rush's students received the best and latest of the science as it flourished in that day. Many of Rush's medical pupils were induced, under his teaching, to subsequently abandon medicine, and devote themselves to chemistry. Examples of such changes will be mentioned in due course. And for this Rush deserves our thanks. He was most conscientious in his work as a teacher, and in every line in which he entered. He was a profound scholar, a politician in the best sense, a philosopher, an educator, a philanthropist. It was he who prompted Thomas Paine to write "Common Sense" and other timely and powerful pamphlets. Although a patriot, it was Rush who addressed an anonymous letter to Patrick Henry, when Continental Congress sat in York, Pa., calling upon him to move in deposing Washington. He signed the Declaration of Independence. Indeed, he was a man of affairs although he wrote—

> "Medicine is my wife; science is my mistress; my books are my companions; my study is my grave; here I lie buried, the world forgetting, by the world forgot."

But the chemical world, or any other part of the world, has not forgotten him. His syllabus exhibits his zeal in extending a knowledge of our science, so that as a teacher of it he can never be set aside. Nor will the world ever forget his wonderful work and unselfish devotion to the people of this city upon the visitation of yellow fever within its precincts. Then it was that Rush rose magnificently above ordinary personal matters, and in so doing saved the lives of thousands of his fellow citizens. He was a very religious man, though Dr. Weir Mitchell once said to me, " Rush could swear harder and pray longer than any man in town." His students were devoted to him, and his interest in their personal welfare is shown in the following quotation from a letter to one of them who had settled in a distant western village:

" My advice to you is to remain where you are. You will grow with the growth of the settlement. Purchase, if possible, and upon credit, a small farm. A little debt will make you industrious and furnish you with an excuse to send in your bills as soon as your patients recover. . . . A competence, books, ' alternate labor and ease,' . . . a good wife, a few friends, vicinity to a church, and a conduct regulated by the principles of the Gospel, constitute the sum total of all the happiness this world is capable of giving, and these may all be possessed and enjoyed in your present position."

But dark days for the colony were approaching. Men's minds were then, as they are to-day, filled with serious affairs, and while research in chemistry was prosecuted, it did not command attention to the exclusion of all else. As " Old Philadelphia " was the theatre in which were enacted so many of the momentous deeds of the Revolutionary period it is in vain to search for evidences of activity in chemistry then. It was only at the termination of hostilities—in the early years of the last decade of the eighteenth century—that the science again appears. It is observed in theses of medical students. In most instances it is rather methods of chemical analysis which are discernible and, singularly enough, in connection with plants or botanical subjects, or, in not a few instances, with fluids of the body, the blood, bile, etc. And many of these studies were inspired by Rush. To him their authors acknowledged their indebtedness for guidance and supervision. The modern chemical student would profit by a study of these early efforts. They were products of serious thought and painstaking, experimental endeavor. They accentuate the obligation which we of the present owe to Rush, whose vocation was medicine, but whose avocation—chemistry—gripped his attention, if not constantly, at least at intervals, when he must have fondly striven to carry forward the aims of his old master, Joseph Black. We hear little of theory. The word phlogiston is not conjured with. It appears and penetrates the explanatory changes now and then, but it does not dominate the thought. Nowhere does Rush speak in its defence. He accepted it notwithstanding the French views were familiar to him; indeed, I have often been disposed to think he may have, in his later years—in his chemical talks—given these newer ideas very favorable consideration, otherwise there could be no proper way of explaining the decided leaning of many of his students towards the new ideas of combustion, respiration and oxidation. True, James Hutchinson (1725–1793) followed Rush in the chair early in the '90's, but there has not been found any sign of his influence upon the chemical thought of that particular period, although he was accorded "a gold medal for his superior knowledge in chemistry," and had received some of his training under the distinguished Dr. Fothergill of London. His occupancy of his station was brief, so that a vacancy occurred about 1794. These facts are mentioned in passing.

It is reasonable to assume that the great popularity of Rush with students, his paternal oversight of them in the capacity of preceptor, afforded him the opportunity to discuss science in general and led him ofttimes to emphasize our science as the one which was destined to create remarkable changes of a beneficial character. He saw and pointed the way to his juniors, otherwise we would be at a loss to understand their frequent affectionate allusions to his fatherly interest, guidance and aid.

The devotees of chemistry at this time, in the city, were mostly young men. Among them were James Woodhouse, Adam Seybert and John Redman Coxe. While not classmates, yet they were in the University together, and appear to have been protégés of Rush. Especially was this true of Woodhouse and Coxe. The former of these was closely associated with Rush, his preceptor, and before or immediately following his graduation in medicine, instituted the historic Chemical Society of Philadelphia, which should ever be cherished in the memories of all American chemists. These young men experimented and discussed with their friends the problems of their common science, but there was lacking an energetic spirit in their group. The awakening, however, soon came. It arrived with the appearance of Joseph Priestley, whose life story is so familiar that only those parts essential to the present picture will be again introduced. He left England in April, 1794, reaching New York in the following June, where his reception was of a most flattering nature; but he yearned for Pennsylvania, for Northumberland in particular, where his son had preceded him and where it was fondly hoped there would be a refuge for all dissenters whose life, like his, had been made unendurable in England. In Philadelphia he was received with the same honorable distinction which marked his entrance to New York. In fact, the vacancy in the chair of chemistry at the University already alluded to, prompted the trustees to elect him to the same; but wishing to establish a college at Northumberland wherein he might freely teach his peculiar religious tenets, and for family reasons, he was led to decline it. It has also been said by Priestley's son that later, upon the death of Doctor Ewing, Provost of the University of Pennsylvania, "it was intimated to my father by many of the trustees, that in case he would accept of the appointment, there was little doubt of his obtaining it." These overtures he discouraged.

It was never easy for Priestley to remain silent on political questions, so that even President Adams found it necessary to send him a gentle admonition. Subsequently, this distinguished gentleman wrote:

> "I never recollect Dr. Priestley but with tenderest sentiment. Certainly one of the greatest men in the world, and certainly one of the weakest."

Dr. Rush said of him:

> "His conversation was always instructive. . . . He received in legacies $2000, $500 and $100 from three different people since his arrival in America . . . he told me 'Franklin always wrote down his arguments or reasons for or against any measure before he decided on it and carefully read his papers, etc.'"

Priestley's enemies followed him to his forest home and sought to harm him and place him in a wrong, compromising and even hostile attitude, for, December 8, 1794, he wrote from Northumberland, Pa.:

> "I am satisfied that neither Mr. Vaughan, or Mr. Hone, any more than myself, had any thought of encouraging the French in any hostile attempt upon England."

And to another friend, on January 26, 1795, he wrote:

> "We agreed in desiring him to inform that person that, whatever might be the opinions, or wishes, of any party in other respects, no Englishman would join the French in such a scheme, but that they might depend upon being opposed by the whole force of the Kingdom. . . . In giving this advice, which we believed to be well founded, we thought we did service to our country, as it would tend to make the leading men in France (if our opinion should come to their knowledge) drop the design. . . . Leaving the country presently after, I know nothing of what followed."

In these communications may be observed his connection with political matters, although he was occupied with thoughts about the new college.

As these lines were penned there came to mind that within reach of my hand stood the ancient lock and key of the Birmingham Home, the chemical balance used by the doctor, and volumes on a multitude of subjects, so that I am disposed to say "Priestley in America" would most surely prove a fruitful subject for all who might be interested in chemistry in this country. It would be a new chapter. We know Priestley principally as an English philosopher, and have in mind his activities on English soil; and we cannot forget those beautiful allusions made by T. E. Thorpe:

> "If by some evil chance the cold and damp of this coming winter should drive some of you to the dentist, and if, after seating you in that awful chair and harrowing your distracted nerves with the sight of his murderous tools, he humanely offers to send you to sleep with his nitrous oxide, by all means let him, and when you wake with the sweet consciousness that 'it is all over,' give a passing benediction to the memory of Priestley, for he first told us of the existence of that gas." . . . "If, too, as you draw up to the fire betwixt the gloaming and the mirk of these dull, cold November days, and note the little blue flame round the red-hot coals, think kindly of Priestley, for he first told us of the nature of that flame when in exile to which our forefathers drove him."

As Priestley advanced in age, it is said he lost none of the sprightliness, vivacity or clearness of his mind. He "was one of the most instructive and interesting preachers and colloquists I have ever known," declared an old Philadelphian, while another wrote: "I never passed half an hour in conversation with him that did not add something to my stock of useful knowledge." He was most versatile. But I am not here to eulogize him. That has been done elsewhere, and yet I cannot refrain from repeating that "Priestley in America"—carefully, conscientiously and exhaustively worked out, would constitute a real contribution and we would jealously contend with our English cousins as to whether he really was not ours, for we would not, no matter what else we did, be guilty of printing such an epitaph as the following which appeared many years ago in an English paper:

"Here lie at rest
In open chest
Together packed most neatly
The blood and veins
The bones and brains
And soul of Dr. Priestley."

It was on his visits to Philadelphia that he met those interested in his beloved science. He was familiar with all the laboratories. He dined and spent hours in the society of the students in the city. He was a member of the Chemical Society, and of the American Philosophical Society, and attended their gatherings. It was thus that he was enabled to impart his enthusiasm for experimentation to those eager for it. It is an established fact that Woodhouse, Seybert, Silliman, Hare and many others were in his company when interesting experiments were in process. His home here and that at Northumberland were open to students. They responded to his cordial invitations. Caldwell tells how Woodhouse upon entering on his professorship at the University in 1795 immediately put his good laboratory in excellent order and proceeded to follow up experimental work as he had never before done.

From the "Life of James Woodhouse" * we learn how Priestley's publication of his memorable paper on "Phlogiston Established" caused him to experiment unceasingly in order to overthrow the views of "Old Oxy-

* James Woodhouse—A Pioneer in Chemistry, J. C. Winston Co., Philadelphia, Pa.

gen." While the younger chemists of the town were advocates of the French doctrine they were unshaken in their loyalty and devotion to Priestley. The sensation and the new life he introduced extended beyond Philadelphia. At Princeton, McLean, at Columbia, Mitchill, and at various other centers the writings of Franklin's "honest heretic" produced a profound impression, and evoked much experimental endeavor. So that his coming to America must be regarded as providential so far as the science of chemistry is concerned. It dates a new birth for the science. Would that somewhere there might be an appropriate monument to this grand old man—the Father of Pneumatic Chemistry!

In the spring of 1798 the members of the Chemical Society of Philadelphia listened to an admirable, annual oration entitled "A Sketch of the Revolutions in Chemistry." It is an epitomized history of our science. It must have made a very favorable impression because a minute of the Society exists in which its author is requested for a copy for publication. In the latter form it was widely distributed. It was most sympathetically reviewed by the Medical Repository, which concurred with the author "in his spirited concluding observations on the utility of diffusing knowledge throughout America." The oration showed rather extensive reading and much information on the part of its author—Thomas P. Smith (1777–1802). For a young man it was a most creditable contribution.*

I have narrowly scanned the literature of the period in which Smith lived without discovering very much about him. In one of Robert Hare's Letters † he wrote (1804):

"Mr. Thomas P. Smith, a young gentleman of our city, of an ardent and inquisitive mind and not unenlight-

* Chemistry in America, p. 13. D. Appleton & Co., New York, 1914.

† Life of Robert Hare, J. B. Lippincott Company, 1917.

ened by the rays of science or of genius, having in a tour through Europe made a considerable collection of minerals, had the misfortune to lose his life when he had just arrived in sight of that native country for the ornament and improvement of which his researches had highly qualified him. . . . The bequest of his minerals to the American Philosophical Society, may certainly be considered as promising publick benefit."

Smith's death occurred in 1802. The *National Intelligencer* for October 2nd of that year said of him:

"With the youth of five and twenty has perished not the blossoms, but the mature fruit of age. Eulogium is often extravagant, but truth sometimes sustains her boldest panegyric; and when she declares that Thomas P. Smith, for science, had no superiors for his age in the United States, and promised, in the progress of life, to have few equals, she pronounces the sacred language of Truth."

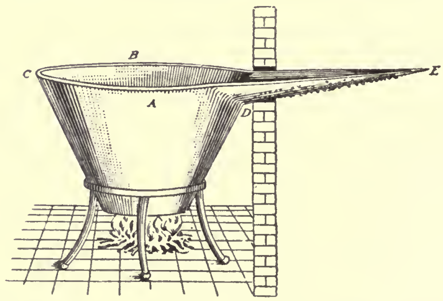
This surely was high encomium. Where Smith acquired his chemical knowledge is unknown. His oration was dedicated to Robert Patterson, Vice-Provost and Professor of Mathematics in the University of Pennsylvania, and later Director of the United States Mint, but the name of T. P. Smith fails in the University records.

When the oration was delivered Woodhouse had probably convinced the members of the Chemical Society that the French theories were correct. Smith was an active member of that Society. He served on many of its committees.

His European visit, to which allusion has been made, was quite extended. He met Hatchett, who had found a new element in a mineral of the Royal Society Collection which had been sent in from Haddam, Connecticut, and been called there *Columbite* by Governor Winthrop. This new element Hatchett accordingly designated *Columbium.* The narrative continues that it was Smith's hope to uncover considerable quantities of columbite and have it investigated here and abroad. That hope was never realized. He was killed on shipboard by the explosion of a gun.

Smith's name is attached to nearly all of the advertisements of the Chemical Society, announcing its willingness and readiness to analyze and report upon all substances submitted to it. The laboratory in which this public service was rendered and where research was conducted was on the first floor of the first medical building of the University of Pennsylvania, located on South Fifth Street, between Chestnut and Walnut Streets. It may have been in or adjacent to the room in which Woodhouse prosecuted his experimental labors.

In the "Transactions of the American Philosophical Society," 4, 431, is "An Account of a Kettle for Boiling Inflammable Liquids," by Smith, who there refers to the "unhappy accidents that occur from vessels containing inflammable fluids boiling over and setting fire to the buildings in which manufactories of them are carried on," and then he proceeds with the description of his protective device:



"Let ABCD represent a large kettle; DE, a spout running out to the distance of three or four feet, commencing at D, four or five inches from the brim of the kettle, and the termination of it E, just as high as the brim C. Let the bottom of this spout be covered with wet sponges or rags. Now suppose the kettle to be filled up to D with any fluid, then as soon as it commenced boiling it would rise in the kettle, and in rising but a small perpendicular height, would pass a considerable distance up the spout DE: here the liquid would cool and of consequence fall back into the kettle, and the whole subside to its original height. This would occur as often as the fluid rose above D, as the evaporation from the wet sponges or rags, would keep DE constantly cool."

To illustrate the status of chemical ideas in the period of which I am writing let me read to you:

"An Essay on the Muriatic Acid and Its Combinations" contributed by Smith to the *Weekly Magazine,* 2, 297. It begins:

"This acid is perhaps distributed more equally and with more profusion over the face of the whole earth than any other. The most usual form under which it is found is in union with soda, forming the muriate of soda or common salt. This salt is to be found, almost everywhere, in combination with earth or water: from this general distribution, and its utility as a condiment, and in many processes of art, it should certainly demand considerable attention from the chemist.

"The muriatic acid cannot be obtained in a state of purity except in a gaseous form. That which is sold in our shops is a solution of it in water, and that too adulterated by some colouring matter, generally iron: for when it is pure it is perfectly colourless. All experiments which are intended to ascertain the exact properties of this acid, should be made on the gas obtained by decomposing any of its combinations and receiving it over mercury;* but in the following essay we shall consider that fluid sold in our shops under the name of Spirit of Sea Salt.

"This acid has never been found in a native state. To obtain it for commerce the usual way is to take a quantity of common salt, decripitate it, put it into a tubulated retort with the receiver previously well luted on, and then pour one-half its weight of sulphuric acid on it.

* This gas cannot be considered as pure muriatic acid, but as muriatic acid dissolved in caloric.

The muriatic acid then comes over and unites to a quantity of water which must be previously put into the receiver. The acid thus obtained emits a very pungent vapour, and is of a light orange colour. Its specific gravity is less than that of the sulphuric or nitric acid.

"The base of this acid is unknown. Dr. Girtanner has asserted that it is hydrogene, but on what grounds I do not know. M. Berthollet suspects the radical to be of a metallic nature. Becher supposed that the muriatic acid is formed by the union of vitriolic acid united to his mercurial earth, and Stahl followed his opinion.

"It acts powerfully on some of the metals, particularly zinc; and during the operation, the water with which it is combined is decomposed and large quantities of hydrogenous gas are disengaged; the oxygene of the water unites to the metal and oxides, and this oxide is then dissolved by the acid and forms a neutral salt.

"The best test for the detection of the presence of this acid is the nitrate of silver. This test is so very accurate that a single drop of it will detect the presence of the smallest portion of acid dissolved in a large quantity of water.

"It forms neutral salts with all the alkalies and earths and most of the metals. The most general and useful of these combinations are with ammoniac forming sal ammoniac, and with soda forming common salt.

"In the distribution of this invaluable neutral salt * over the whole earth, the wisdom of nature is perhaps as conspicuous as in any other of her operations. Had she confined it to a single part of the earth what endless contentions would have existed for the possession of that place. That place would have become over-populated, and the rest of the world unpeopled, or dependent on its inhabitants for this necessary article of subsistence. But as if disdaining that narrow scheme of policy that would circumscribe all good within certain boundaries, she has poured down her blessings with an equal hand on every country she has designed as the abode of man. Those things which are everywhere necessary to his existence, she has everywhere distributed: and those which were intended to add to the pleasures of life, she has suited to

* Common salt or the muriate of soda.

the various climates he inhabits. To him whom she has placed under the burning line she has given large shady trees whose branches are always loaded with delicious fruit, whose cooling shade serves to mitigate the fervour of a vertical sun; whilst the tamarind, the citron, or the orange from its boughs, destroys that thirst which would otherwise perpetually torment them. To the inhabitant of the frozen regions round the pole, she has given an abundance of animals whose skins are furnished with fur which, worked up into garments defends these people from the inclemency of their climate; and in addition to these, that most useful of all animals, the reindeer. And in the intermediate climates between these extremes, which experience, by turns, almost all the fervour of the one and the rigour of the other, she has blended their productions in such a manner as to suit them to the various vicissitudes of heat and cold to which their inhabitants may be exposed. At first view, indeed, of their situation, the inhabitant of the torrid zone, surrounded by everything which can delight his senses, may appear far happier than the shivering being who draws a laborious subsistence amidst mountains of ice and fields of snow; but when the one, by the ease with which he procures his subsistence, is rendered weak both in body and mind, and submits to every tyrant who, by fraud can deceive, or by force subdue him; and the other is rendered active in all the faculties of both by the constant exercise of them, and possessing and determined to defend that greatest of goods, liberty, we cannot so certainly determine in favour of the former.——I must be pardoned for this lengthy digression. When I commenced it I had no idea of drawing it to the length I have, but as I advanced, the subject expanded before me. I will now conclude it by stating one of the most beautiful facts, on this subject, in existence.

" In the mountains of South America, where the natives would find the utmost difficulty in procuring salt from the seashore, a plant grows, which every morning yields a very considerable quantity of fine salt. This plant grows in such abundance that the natives procure from it sufficient quantities of salt to serve them for every purpose; and they prefer it to that procured from the sea. How beautiful then is this system of nature! How worthy of admiration and investigation!

"The muriatic acid is capable of combining with a quantity of oxygene, greater than sufficient to saturate its basis. In this state it is called oxygenated muriatic acid and possesses properties very different from those it before possessed.

"The way to procure it is by distilling the common muriatic acid on the oxides of manganese, lead or mercury.

"It possesses so weak an affinity to the superabundant quantity of oxygene, that mere exposure to light will cause it to part with it.

"It is to Scheele we are indebted for the discovery of this acid. He formed it, in 1774, by employing the muriatic acid as a solvent for manganese.

"M. Reboul has observed that the concrete state of this acid is a crystallization of it, which takes place at three degrees of temperature below the freezing point of Réaumer. The forms which have been observed are a quadrangular prism truncated very obliquely and terminated by a lozenge. He has likewise observed hollow hexahedral pyramids on the surface of the liquor.

"The oxygenated muriatic acid has an excessively strong smell. It acts directly on the larynx, exciting coughing and violent headaches. Its taste is sharp and bitter. It speedily destroys almost all vegetable colours.

"M. Berthollet fabricated gunpowder by substituting oxygenated muriate of potash instead of nitre: the effects it produced were quadruple. This powder, which was first made in the large way at Essone, exploded the moment the mixture was triturated and destroyed several people.

"The oxygenated muriatic acid has lately been applied with great success to bleaching linens and cottons.

"It has the most powerful action on metals, instantly oxiding them. It dissolves them without effervescence.

"It precipitates mercury from its solutions, forming corrosive sublimate.

"It converts sulphur into sulphuric acid and instantly whitens the very black sulphuric acid.

"When mixed with nitrous gas it passes to the state of muriatic acid and converts part of the gas into nitric acid.

"Dr. Beddoes has asserted that it will make negroes white.

"It has lately been applied with great success in the treatment of several diseases. It very quickly produces salivation."

To some persons it may sound almost puerile; consider, however, its date, and that its purpose was the diffusion of chemical knowledge among the masses.

As indicated by the quotation from Hare's letter, Thomas P. Smith had an interest also in mineralogy and geology, although these sciences were as yet considerably in the background.

In the "Transactions of the American Philosophical Society," 4, 445, Smith describes the occurrence of basaltes on the Conewago Hills, east of the Susquehanna, and about half a mile to the north of Elizabeth Town, and at Campbell's Town and Grubb's Mines. He considered them of Neptunian origin because they were interspersed with large masses of *brechia,* composed of silicious pebbles. It is not a profound paper in any sense, any more than another which he published in 1799, after making what he termed "a little journey" into lower New Jersey, his purpose being to closely observe the geology. Later, on speaking of the pine barrens, he emphasized that they were devoid of all vegetable mould, and added, "but this may be owing to the sand being so loose as to suffer it all to be washed into the earth," and then he naïvely, almost cruelly, proceeds:

"A view of this country would almost have superseded the necessity of Van Helmont's experiment of growing a willow in sand with distilled water. All the woods here grow under these circumstances."

Smith was, so to speak, a chemist of minor degree, but he played a very necessary part in the local development of our science. He is entitled to favorable mention.

Had he lived he would probably have made a deeper imprint.

Three young men of note in the middle of the last decade of the eighteenth century who now appear on the horizon, and to whom reference has already been made, were: James Woodhouse (1770–1809), Adam Seybert (1773–1825), and John Redman Coxe (1773–1864). Woodhouse and Seybert were natives of Philadelphia, while Coxe was born in Trenton, N. J. They were graduates of the Medical School of the University of Pennsylvania, but not in the same year. Woodhouse received his academic training in the College of the University; Seybert was educated by tutors in his home; and Coxe acquired his academic tuition in Edinburgh. Woodhouse was born in 1770, and Seybert and Coxe in 1773. They were interested in chemistry before the coming of Priestley, whom all of them knew personally and whose character and work mightily influenced them. The intense love of Woodhouse for our science had led him to found the Chemical Society of Philadelphia in 1792, two years prior to the advent of Priestley; and Rush, fondly hoping that the latter would accept the election to the chair of chemistry in the Medical School of the University, formerly held by himself, and believing, because of Priestley's advanced years, that he would not occupy the same for a great while, conceived the idea of having Coxe, whom he greatly admired, go abroad to continue his chemical studies in preparation for the chair; but, when Priestley, after prolonged consideration of the invitation, concluded not to accept the post, there was consternation in Philadelphia chemical circles. Rush, it may be remarked in passing, was usually in a state of belligerency with his colleagues and associates unless they were willing to serve him subserviently, so now his enemies, probably aware of his plans for Coxe, set about vigorously to place Benjamin Smith Barton, or Adam Seybert in the unoccupied post. Rush at once championed the candidacy of Woodhouse, who had shown marked predilection for the science and given substantial proof of his chemical knowledge and powers. A recently published life of Woodhouse * gives the details of the struggle, from which Woodhouse emerged the victor. It was in 1795 that he assumed the duties of his chair.

Woodhouse stands out prominently among American chemists. His name became known beyond this city and beyond the seas. My purpose is to give here only the major details of his career, which continued but fourteen years. His experimental work, familiar to and often seen by Priestley in its process of development, aided in establishing the true ideas of combustion, respiration and oxidation. He made America, so far as chemistry was concerned, a member of the French group of thought, and aided materially in the overthrow of the doctrine of phlogiston. This fact should be taught to students of chemistry in our land. He was a consummate, painstaking experimenter. A study of his exhaustive labors to eliminate phlogiston will create in any student a profound respect and admiration for him. He also demonstrated what occurred in the breathing of plants. He isolated the metal potassium in 1808 by heating caustic potash with soot, in an iron vessel. This was accomplished before Gay-Lussac and Thénard did it. The world has been ignorant of this contribution. About the only person who laid any stress on this particular achievement of Woodhouse was Thomas Cooper, who wrote of it and spoke of it very frequently; yet, no credit ever fell to Woodhouse for this epoch-making discovery.

Woodhouse developed the chemistry of plants in a very extraordinary manner. He also analyzed many minerals. True his results have now little value. This is principally

* James Woodhouse—A Pioneer in Chemistry, J. C. Winston Co., Philadelphia, Pa., 1918.

due to the imperfect methods then in vogue. Another striking feature of Woodhouse's activities was his unswerving effort to develop applied chemistry. A consuming desire with him seemed to have been to win benefits for our country and its people with the help of his science. This is particularly noticeable in his effort to get pure camphor. He believed in research. He was the father of the laboratory method of instruction in chemistry. His published books were authorities in their day. He devised useful apparatus. He was devoted to Priestley, and imparted his research spirit to many young, enthusiastic chemists. His introduction of Hare and Silliman into the mysteries of our science is but a single instance of the way in which he advanced chemistry in "Old Philadelphia," and throughout the Republic. As his life record is told exhaustively elsewhere, let this brief mention of him and his achievements suffice. He is certain to be recognized as a pioneer in his special field. It is to be regretted that one possessed of Woodhouse's splendid and high purposes in his science should have been called away in his prime. He died, deeply lamented and greatly honored, in his thirty-ninth year.

Interesting, indeed, was the career of Adam Seybert (1773-1825). To begin, his doctoral thesis was remarkable. It was emphatically experimental, and its purpose was to refute the idea of putrefaction of blood in living animals during disease. Boerhaave had taught that the blood became putrid in many diseases and "under the imposing authority of his name, and by means of his industry the idea was diffused throughout almost the whole globe."

However, there were here and there students who rejected this idea, and their opposition was conducted at this time with a great deal of ardor. Hence, it is easily understood how Seybert entered with zest upon the refutation of the old notion. He remarks, "I found that it had never been put to the test of fair experiment, but that speculative reasoning and a few indecisive facts were the chief support of the arguments on both sides. . . . I now determined to contribute my mite toward investigating the matter by experiment." Then follows the presentation of numerous observations made upon animals, generally dogs. It is needless to give the experiments in detail. Suffice to state that his early ideas were confirmed by experiments.

That a young man, not yet twenty years of age, should have been so thoroughly versed in the medical literature of that period and earlier periods, and that he should have originated the modes of attack upon the problem before him indicates that Seybert possessed a very keen intellect. The present-day antivivisectionist would, in all probability, decry his endeavors; yet they brought positive results. Students of physiological chemistry should turn back to those early studies in what is now their distinct province. They would realize that the application of chemistry to the clarification of physiological difficulties was indulged in at a date earlier than they imagined. It is also patent that chemistry was the key by which Seybert proposed to solve his problems, which is strong proof, that notwithstanding he was a medical student there was constantly with him a fondness for chemistry. The composition of his thesis is excellent and shows a high degree of culture in the author. It covered seventy-six printed, octavo pages and was issued by the old Stone-House Press, No. 41 South Second Street, Philadelphia. It was dedicated:

"TO THE REVEREND

JUSTUS HENRY CHRISTIAN HELMUTH, D. D.

Professor of the German Language

As a small tribute of gratitude for his care and attention, in directing and superintending my studies, whilst under his tuition, at the University."

These lines are very interesting, particularly when we have been told that Seybert was trained altogether in the common schools or under the parental roof. The name of Seybert is nowhere enrolled in the collegiate department of the University of Pennsylvania. It is only recorded in the Medical School, from which he was graduated in 1793 with the thesis just described. If Helmuth was his teacher, then Seybert was either a student of the College or a private student of Helmuth. The lines, " whilst under his tuition, at the University " would seem to definitely establish his presence in the College. The period in which this occurred followed so closely upon the merger of the old College of Philadelphia with the University of the State of Pennsylvania, that many documents passed into oblivion. Records of students also disappeared, or were faulty in many particulars. It would not be claiming too much to enroll Seybert in the College, from which he passed to the Medical School. The fostering care of Helmuth may also have been due to church relations. The family of Seybert was of the Lutheran faith, and Helmuth was a pastor of " the German Lutheran Zion Church—the largest and finest house of worship in North America, with a seating capacity far in excess of any other in the City . . . it stood alone among all the other denominations, as a firm rock against which the sea of unbelief had no power." Mathew Carey, a prominent and devout Romanist, said of Helmuth, " he stands a living miracle of preservation." This was in connection with the heroic work of Helmuth performed during that sad period of 1793, when the scourge visited Philadelphia.

And to Dr. Caspar Wistar, his beloved preceptor, Seybert wrote:

" Sir:

" In addressing this Inaugural Dissertation to you, everybody that knows you will readily admit the peculiar propriety of the tribute. Your justly acknowledged abilities leave no room to doubt that I have an interest in making this offering. But, whilst, I candidly admit this, I feel and confess profound obligations of gratitude to a beloved master, for his very beneficial instructions, and his many courtesies and attentions. To whom can the following production, with more evident propriety, be inscribed than to him who planted the Seed of Knowledge, and, with anxious solicitude, superintended the growth? To you, sir, I am indebted for whatever progress I may have made in Medical Science; and I am ambitious that the first fruits of my labours should be presented to the world under the adorning sanction of your patronage.

" The cordiality of your friendship has naturally inspired me with sentiments of esteem and attachment, which it will ever be my pride, as it is my duty and interest, to cherish.

" Believe me, sir, nothing can ever obliterate from my mind the mingled sentiments of gratitude and esteem with which I remain

" Your obliged friend and pupil,

" A. SEYBERT."

The preceding lines forecast the hearty support which Wistar, a few years later, gave to Seybert in his candidacy for the chair of Chemistry in the University, when he was one of the opponents of James Woodhouse, so powerfully endorsed by Rush. There were those who regarded the contest more as a struggle between Wistar and Rush, than between the aspiring young chemists, who were not only contemporaries, but probably quite intimate, although subsequent occurrences may have, to some degree, estranged them. They were at heart genuine lovers of their chosen science and met frequently in the laboratory of the Chemical Society of Philadelphia, and the Hall of the American Philosophical Society, where both were active and regular attendants upon meetings. Both were secretaries of the Society.

A few years later, in the continuance of medical chemical studies, Adam Seybert immersed a piece of polished gold in the saliva of a patient who had been using mercurial medicines. No alteration was observed after contact of several days. On placing the gold strip in the serum of the blood of the same individual no change was noticed. Testing the same serum with copper and finely divided charcoal revealed nothing. Many other chemicals were applied in the hope of detecting the mercury. The results were always the same, with the conclusion "that mercury is combined with the blood in such a peculiar way that the above means have not been adapted to detect it." And how easily it is done!

We next learn that Seybert crossed the sea with the purpose of studying, for a brief period, in London and Edinboro, where his time was devoted mainly to medicine, but soon thereafter he was in France at the École des Mines. Medicine had been shelved and all attention was given to chemistry and mineralogy. Who can doubt but that it was the inspiration and impetus received at the University of Pennsylvania and in the meetings of the Chemical Society of Philadelphia which caused him to devote himself to the two sciences which were just beginning in his native land? Finishing in Paris, he went to Goettingen, where he continued special studies in chemistry and mineralogy. One wonders by what chance he went to Germany. His teachers in his native city had received their education in the Scotch and English centers. May I suggest that possibly it was due to the influence of Benjamin Smith Barton, who won his M. D. degree in 1789 at Goettingen and immediately thereafter settled in Philadelphia, joining the science circles there? Certainly these young men must have met and exchanged thoughts and plans. Barton and Seybert followed in the train of

Wistar rather than in that of Rush. Confessedly much of what I have just said is pure surmise, although the longer I think upon it the more disposed am I to believe it approaches the truth.

But there are other points much more interesting in this chemist's life. For instance, some years later Seybert, in describing Pennsylvania minerals, said of *celestine:* "A German mineralogist, by the name of Schütz, discovered this mineral near Frank's Town, Pa. I have seen the Pennsylvania specimen in the collection of Professor Blumenbach, of Goettingen; it was a part of that which Mr. Schütz carried to Europe."

So here he was studying with the renowned Blumenbach. Singularly enough, the writer, eighty years later, while a student in Goettingen, saw and handled a specimen of celestine, labelled as from Pennsylvania, and was told the writing upon the label was that of Blumenbach! Probably, Seybert, whom the writer never knew and at that time had never heard of, handled and studied the same celestine specimen. And, in chemistry, Seybert without doubt heard and worked with J. Fried. Gmelin, the author of that voluminous three volumed, first history of chemistry—a real encyclopædia, now forgotten but once an authority from which later, more familiar texts received the treasures they have brought to our eyes.

This foreign, student trip of Seybert extended, as nearly as can be ascertained, over a period of two years. On his return to "Old Philadelphia" "he engaged in business as chemist and mineralogist" in a shop located at 168 North Second Street, where he rapidly acquired a notable collection of minerals. It was at that time the best in Philadelphia. In 1814 it was purchased for the new Academy of Natural Sciences at the price of about $800.

Seybert's knowledge of minerals caused Silliman in

1803 to request him "to name the few specimens that at that time constituted the collection belonging to Yale."

But let me revert to some earlier experiences:

Seybert believed that the air over a large body of water is always purer, *cæteris paribus,* than that of the adjoining land, owing, as he conjectured, to a decomposition which the water may suffer from the action of the sun's rays; and likewise, in part, to its absorbing many foreign matters, which, on land, are more or less intimately mixed with the air in a mechanical way.

As to the state of the air in different situations on land, Seybert adopted the conclusion of all the more respectable eudiometrical experimenters, that the results vary but little. And he was disposed to admit the opinion of Fontana, that "the difference in the purity of the air, at different times, is much greater than the difference between the air of the different places."

It will be well to observe some of his experiments which led to this conclusion. He said:

"My first experiment on land air was performed August 2, 1796. Two measures of air in the yard of my lodging, when mixed with one measure of nitrous air, left upon mixture 2.48 of a measure; and after shaking the tube 1.79. I then added another measure of nitrous air and 2.65 remained.

"I then submitted air to the test of the eudiometer which I had previously collected in different streets of this city, viz., in Water between Market and Arch Streets; in Spruce near Fourth Street; in Chestnut near Fifth; and in Market between Second and Third Streets. Each of these airs gave nearly the same result, and generally agreed with that of the air of the yard of my lodging: none of the experiments show a difference of 0.02 of a measure.

"Similar experiments I have since repeated and the result was the same.

"August 3d. I collected air on the top of the hill whereupon Dr. Smith's Observatory stands at the Falls of Schuylkill, five miles from Philadelphia. In another phial I received air from above the middle of the road directly at the foot of the hill. And immediately on my return home I submitted them and the air of the yard to experiment and found them to agree exactly as follows:

Upon mixture 2.48

After shaking the tube 1.78 and upon adding a second measure of nitrous air 2.63 remained.

"August 5th. I collected air from above two different marshy situations below the rope-walks to the south of this city. It is of consequence to remark that these marshes are overflowed by the tide. Another phial I filled immediately before entering the city in Front Street. These airs suffered an equal diminution from the mixture of nitrous gas, viz., 2.47 upon mixture; after shaking the tube 1.79; and after adding a second measure of nitrous gas 2.64 remained.

"The air near my lodging yielded upon mixture 2.49; after shaking the tube 1.78; and upon the addition of a second measure of nitrous gas 2.62.

. . . .

"To these experiments I will subjoin those I made on the ocean during a passage from Bourdeaux to Philadelphia.

"My experiments at sea sufficiently prove that the atmosphere is considerably purer there than it is on land. Though there are some trifling differences in the results of several experiments, I have no reason to believe that they were owing to the different situation in point of longitude or latitude in which they were performed. I can form no system respecting such variations. Winds, temperature, rain, etc., do not seem to have produced them. As they did not observe any regularity in their occurrence, they may perhaps be attributed to certain unperceived errors which are unavoidably attendant on such trials.

"That the air at sea should appear nearly of the same purity in different latitudes does by no means astonish me; for if land air has certain matters mixed with it they are perhaps *absorbed;* and if my supposition be true, that the influence of the sun's rays on the water tends to increase its purity, the opinion I entertain is not surprising. For when once purified there are perhaps none, or few causes to render the air noxious after it is wafted from our towns and cities over a large body of water.

"It occurred to me that probably the purity of the air at sea varied at different periods of the day; to satisfy myself on this point I made several trials on the 10th and the 17th of June last. On the 10th I performed them at 9 o'clock A.M., at 12, and at 6 o'clock P.M. On the 17th at 9 A.M. and at 12 o'clock. The result of all the experiments of the same day was exactly similar, at least not perceptibly different.

"Whether or not sea air might be rendered more pure by agitation with water, appeared to me to be a question worthy of being ascertained. Particularly as some celebrated men reason that it has this effect, and must hence be looked upon as one of the greatest resources which we have for purifying the atmosphere. Sir John Pringle and Dr. Ingenhousz are of this opinion. But some of Dr. Priestley's experiments seem to contradict it; and so does the following assertion of the celebrated Scheele, who says: 'L'air ne s'unit pas avec l'eau commune.' Traite de l'air et du feu, p. 5.

"My experiments on this head are as follows: On the 26th and 28th of June, the 2d and 5th of July, equal bulks of sea water and air were agitated for half an hour in my eudiometer tube; but I never discovered any absorption to have taken place; neither was the air rendered pure, as was evident from a mixture with nitrous air.

"It now appeared probable to me that sea water was already saturated with all the gaseous particles it could absorb; and that fresh water when agitated with sea air might diminish its bulk or alter its purity. In consequence of this supposition, equal bulks of sea air and fresh water were agitated as above; but it was not in the least altered. Not entirely satisfied with the fallacy of my conjecture, I boiled sea water a sufficient time to purge it of the air it might contain. I then agitated sea air with this boiled water as above mentioned and found no difference in result from the other experiments. These results tend to confirm me in my belief that if sea water purifies the air, it is rather by adding a somewhat than by absorbing any considerable quantity of effluvia floating therein. Though by this I do not mean to say that certain matters foreign to our atmosphere do not float therein on land. If they exist, perhaps they may be subject to absorption by water."

He gave a brief description of the method of analysis pursued by him. It will interest us, for no doubt every one wonders how he did his work aboard ship.

"I had a glass tube about 14 inches in length, and in diameter nearly half an inch, provided with a graduated scale, made so as to slide upon the tube up or down as occasion required. This scale was divided into one hundred equal parts.

"My measure was a small smelling bottle, containing ʒj. and gr. xvj. of clear pump water. The space occupied in the tube by the bulk of air which this measured could contain was equal to the hundred divisions of the graduated scale.

"My water trough on board of the ship was the common water bucket; on shore it was a common house bucket or tub.

"My method of operating is as follows: After having introduced two measures of the air, whose purity I desired to ascertain, into the glass tube, I introduced one measure of nitrous gas; then, suffering the tube to remain undisturbed for about a minute, I noted down how far the water ascended without agitation; this is what I have called, upon mixture: I then agitated the tube three successive times, after the manner of M. de Saussure, and noted how high the water rose. In many instances I added a second measure of nitrous gas, and thereby completely saturated the air under examination.

"I was particularly cautious of avoiding mistakes from hurry or inattention, and took some pains to guard against all the circumstances Dr. Ingenhousz mentions as liable to produce a variation in the result of experiments of this kind."

In Volume 4, 415, of the "Transactions of the American Philosophical Society, Seybert further discussed particularly the atmosphere of marshes. By experiment he sought to ascertain whether or not the air of the marshes differed from that of other places. He studied air just disengaged from marshy soil and also that collected some distance above the marsh. He concluded that air *above* marshes is not considerably different in its properties from the ordinary atmosphere elsewhere, and that the soil had considerable effect in altering the air of our atmosphere. The various gases arising in the decay of animal and vegetable substances in the soil of the marshes he found " the great cause of the observed alterations." In fact, he considered marshes as necessary to keep the atmosphere in a proper degree of purity: for not only the impure atmosphere but the too pure also, is destructive to animals. And he imagined marshes to have been formed by the Author of Nature in order to operate against the powers which vegetables and other causes possess of purifying the atmosphere, so that the oxygen may exist in proper proportion to support animal life and combustion. The whole contribution of the composition of air is most instructive. It breathes out the true spirit of an honest chemical investigator and deserves mention and record in the annals of the development of chemistry in this country.

It will not be claiming too much if we call Seybert a pioneer in air analysis, although he devised very little apparatus—indeed, nothing in comparison with that developed later by Robert Hare for general gas analysis. Then, further, he was an American pioneer in mineralogy. None of those whom we introduced before him cared much for minerals. De Normandie, Rush and Priestley gave no attention to this science, which Thomas Cooper called the " hand-maid of chemistry." Woodhouse was incidentally interested, largely it would seem because of his friend Samuel L. Mitchill of Columbia, and in part because of intimacy with Seybert, and other students in Philadelphia.

Seybert made " a catalogue of some American minerals found in different parts of the United States," though confining himself mainly to those " in the vicinity of Philadelphia." This task, he says, he was induced to undertake because " many of my fellow citizens were inquiring, as were foreigners who particularly desired specimens." He added, " With regret I mention that mineralogy has been almost totally neglected in the United States." He described forty different minerals, all of which were represented in his own most interesting collection. The remarks in regard to specimens are very helpful and suggestive. He tells of " radiated zeolite (mesotype) found investing hornblende rock, on the canal near the river Schuylkill, about three miles and a half from Philadelphia," and also notes, " I have some specimens of marble found in York County which approach those allowed to be the pride of Italy."

And thus he proceeds in a most attractive fashion. When once mineralogy in this country is developed historically " Old Philadelphia " will figure large and the pioneer studies of Adam Seybert will hold a prominent place. They certainly would merit it.

In this connection Seybert (1808) said of the working of zinc blende for its metal " that sulphuret of zinc was found near the Perkiomen Creek, Montgomery County, Penna., and was announced by me in 1806." James Woodhouse argued that this ore could not be used to get the metal. He quoted many authors to support him. Seybert took up this point and proved that it would yield the metal. He regretted that anyone should promulgate other opinions " when the political situation of the country is such that its foreign relations are interrupted, and much is expected from an energetic application of its internal resources, it is the duty of every citizen to contribute his mite towards the end. When erroneous opinions are propagated and unfounded doubts are excited, it is a two-fold duty to place facts in a true point of view." This animadversion exasperated Woodhouse, who replied in kind; but zinc was mined!

Tradition tells that Seybert was possessed of large means and was therefore capable of doing practically as he desired. He had abandoned medicine and cultivated chemistry and mineralogy because of genuine love for them. In fact he followed many paths as inclination suggested. He was not a recluse, but mingled with men of all walks and was ever ready for service. Hence, he appears as a private on the muster roll of the 2nd Company, Pennsylvania Militia, City of Philadelphia, and on May 19, 1809, delivered a memorable address at a meeting of manufacturers and mechanics of our city, which was printed by order of the committee in charge of the occasion.

The historic records of many countries are not lacking in examples or in instances of men, who, having devoted a goodly portion of their lives to the pursuit of science, have laid it aside to enter the legislative halls. The eminent Dumas was a notable example of this class—a chemist deserting the retort and crucible to don the toga of a senator. Benjamin Rush, pre-eminent in medicine, and a pioneer in chemistry, assumed in later life the burdens of a member of Continental Congress. It is not surprising, therefore, that in tracing the life of Adam Seybert, he should be found in the halls of Congress. In the years 1809 to 1815 and again, from 1817 to 1819, an examination of the Congressional Records discloses the fact that he was not a silent member. On the contrary, he figured largely in all important measures claiming the attention of the National body. In Naval affairs he was deeply interested; they were his particular study. He constantly advocated a strong Navy. Being an ardent patriot, he was emphatic in maintaining American rights on the seas. It was in 1812 that he protested most earnestly against the imprisonment of American seamen by the British. In one of his speeches he said:

"I had the honor to have a nephew on board the Wasp. He informed me that after they had been carried into Bermuda several of their crew were taken and confined in irons; that he saw them in that situation; and that their crime was having fought the battles of our country. What may be my colleague's feelings on this occasion I know not—I hope they are honorable to himself and the House —for myself I wish the subject investigated."

On another occasion he took the opportunity, while discussing a motion to present, in the name of Congress, a gold medal to Captain Isaac Hull, of the frigate *Constitution,* for the capture of the British frigate *Guerriere,* the propriety of also giving some "distinctive or medals to the crew of the *Constitution,* who, he thought, were too generally overlooked in such cases."

While Seybert was a young member of Congress, Mathew Carey, of Philadelphia, addressed a series of letters to him on the subject of "The Renewal of the Charter of the Bank of the United States." These letters formed a booklet of eighty pages, and upon its title page bore these lines:

"To struggle
In a just cause, and for our country's safety,
Is the best office of the sons of men——
And, to decline it, where these motives urge,
Is infamy beneath a coward's baseness."

This fact is introduced to show that Seybert was looked upon with favor by the thinking men of the Republic. It is most interesting to pursue his activities in the Congressional Records for the years of his service at Washington. His constituents made no mistake when they chose him as their representative in the national body. Being a student, a man of affairs, with a great mass of facts acquired by study and wide reading, and being conscientious and eager to meet his obligations as a representative, he brought to the discussion of the burning issues of the years immediately before and following 1812 new viewpoints, and won for himself recognition and confidence from his colleagues. It was about 1818 that he prepared a rather remarkable volume entitled "Statistical Annals of the United States of America." This was printed by Congress, and in December, 1818, that body resolved "that for supplying the deficiency in the appropriation for the subscription for the Statistical Annals of Adam Seybert . . . the further sum of $400 be paid out of the contingent fund of the House of Representatives." It was a book of character—a very large book. It told of the population, of the lands and commerce, of the imports, the tonnage and navigation, the Post Office, revenues, the Army and Navy, the expenditures and debts of the little Republic. Another interesting fact in the history of this book was that when it reached the *Edinburgh Review,* it was consigned to the celebrated Sydney Smith, who said in his critique, after a lengthy review of the subjects presented by Seybert:

"Such is the land of Jonathan, and thus it has been governed. In his honest endeavours to better his situation, and in his manly purpose of resisting injury and insult, we most cordially sympathize. We hope he will always continue to watch and suspect his Government as he now does, remembering that it is the constant tendency of those entrusted with power to conceive that they enjoy it by their own merits and not by delegation, and for the benefit of others. Thus far we are the friends and admirers of Jonathan: But he must not grow vain and ambitious; or allow himself to be dazzled by that galaxy of epithets by which his orators and newspaper scribblers endeavour to persuade their supporters that they are the greatest, the most refined, the most enlightened, the most moral people upon earth. The effect of this is unspeakably ludicrous on this side of the Atlantic, and, even on the other, we should imagine, must be rather humiliating to the reasonable part of the population. The Americans are a brave, industrious and acute people; but they have hitherto given no indication of genius, and made no approaches to the heroic, either in their morality or character. They are but a recent offset indeed from England; and should make it their chief boast, for many generations to come, that they are sprung from the same race with Bacon and Shakespeare and Newton. Considering their numbers, indeed, and the favourable circumstances in which they have been placed, they have yet done marvelously little to assert the honour of such a descent, or to show that their English blood has been exalted or refined by their republican training and institutions. Their Franklins and their Washingtons, and all the other sages and heroes of their revolutions, were born and bred subjects of the King of England—and not among the freest and most valued of his subjects: And, since the period of their separation, a far greater proportion of their statesmen and artists and political writers have been foreigners, than ever occurred before in the history of any civilized and educated people. During the thirty or forty years of their independence, they have done absolutely nothing for the Sciences, for the Arts, for Literature, or even for the statesman-like studies of Politics or Political Economy. Confining ourselves to our own country, and to the period that has elapsed since *they* had an independent existence, we would ask, Where are their Foxes, their Burkes, their Sheridans, their Windhams, their Horners, their Wilberforces? — where their Arkwrights, their Watts, their Davys? — their Robertsons, Blairs, Smiths, Stewarts, Paleys and Malthuses?—their Porsons, Parrs, Burneys or Blomfields?—their Scotts, Campbells, Byrons, Moores or Crabbes?—their Siddonses, Kembles, Keans or O'Neils? —their Wilkies, Laurences, Chantreys?—or their parallels to the hundred other names that have spread themselves over the world from our little island in the course of the last thirty years, or blest or delighted mankind by their works, inventions or examples? In so far as we know, there is no such parallel to be produced from the whole annals of this self-adulating race. In the four quarters of the globe, who reads an American book? or goes to an American play? or looks at an American picture or statue? What does the world yet owe to American physicians and surgeons? What new substances have their chemists discovered? or what old ones have they analyzed? What new constellations have been discovered by the telescopes of America?—what have they done in the mathematics? Who drinks out of American glasses? or eats from American plates? or wears American coats or gowns? or sleeps in American blankets? Finally, under which of the old tyrannical governments of Europe is every sixth man a slave, whom his fellow-creatures may buy or sell or torture?

"When these questions are fairly and favourably answered, their laudatory epithets may be allowed: But, till that can be done, we would seriously advise them to keep clear of superlatives."

Would it be unpatriotic and disloyal at this moment to ask is it possible that the eminent divine and renowned wit of England never heard of David Rittenhouse, a Fellow of the Royal Society, of Benjamin West, President of the Royal Academy, of Francis Hopkinson, the inimitable satirist, Benjamin Rush, physician and philosopher, Count Rumford, Benjamin Thompson, born in Boston, Robert Hare, whose discoveries live to-day, Samuel L. Mitchill, whose depth and breadth of learning astonished the world, of the savant Franklin, of the eminent painters Copley and Stuart, and of Lindley Murray, whose grammars were the accepted standard at the time he wrote? These were Americans; they painted, they wrote, they experimented, they scanned the heavens—but the sentence, "Who ever reads an American book?", used for the first time in the above criticism, probably would explain the lack of knowledge on the part of the keen and scintillating critic of Seybert's monumental work. It was this quotation, too, which caused James Russell Lowell to say:

"Surely never was a young nation setting forth jauntily to seek his fortune so dumfounded as Brother Jonathan when John Bull cried gruffly from the roadside, 'Stand and deliver a national literature!' After fumbling in his pockets, he was obliged to confess that he hadn't one about him at the moment, but vowed that he had left a first-rate one at home which he would have fetched away—only it was so everlastingly heavy!"

The despised "Statistical Annals" was translated into all the languages of Europe.

On one occasion Adam Seybert made "Remarks on a Passage in the Chemical Writings of the Celebrated Scheele" to the Editor of the *Philadelphia Medical and Physical Journal,* which are not without interest:

"Sir:

"If you conceive the following trifle worthy a place in your *Journal,* you are welcome to make use of it. I do not attach any importance to it, other than its putting chemists on their guard, in admitting implicitly the experiments related by authors of the first respectability as experimenters. The authority of Scheele scarcely admits of a doubt, and his statements of chemical facts and experiments have always been received without hesitation. If errors are committed by men of his eminence, surely we should be very cautious in receiving, as undeniable, the many discoveries stated by the numerous authors of the present time.

"Scheele wished to ascertain, 'whether heat alone would produce air from sulphur?' For this purpose, he 'put a piece of sulphur in a retort, with a bladder tied to it, and kept the sulphur strongly boiling during the space of half an hour.' *

"Our author then says, 'The air in the retort was neither increased nor diminished, and was changed into foul air.' Scheele's Chemical Observations and Experiments on Air and Fire. Kirwan's edition, p. 188.

"I suspected the accuracy of the above experiment,

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* It is proper to remark that, with the sulphur, atmospheric air was confined in the retort.

because, first, I knew that sulphur could be readily oxided in a low temperature. And, secondly, because it is stated that the air in the retort suffered no change as regards its bulk, at the same time that it is asserted to have been changed into 'foul air.' It is well known that Scheele designates azotic gas by the term of 'foul air.' This, certainly, could not have been the result of his experiment, unless an absorption of the oxygenous portion of the atmospheric air contained in the retort had previously taken place.

"There is no misstatement by the translator, for the experiment is precisely the same in the English and French versions. To convince myself of the truth of my suspicions, I determined to repeat the experiment.

"A quantity of the flowers of sulphur was put into a Florence flask, containing atmospheric air: a double fold of bladder was well secured over the mouth of the flask. The vessel was then exposed, in a sand bath, to a temperature sufficient to melt the sulphur, and it was kept in this situation for fifteen minutes. When cool, the flask was inverted over water, and as soon as the bladder was perforated, the water rose to a considerable height: hence an evident diminution of the bulk of the air, which was originally contained in the flask.

"The above experiment was repeated, and, by an accurate calculation, the air suffered a diminution of one-fourth of its bulk. The residuum proved to be azotic gas."

There was a strong philanthropic trait in the character of Seybert, shown in part by the fact that he made liberal bequests for public objects, and upon his death it was found, among other things, that he had devised $1000 for the education of the deaf and dumb, $500 to the orphan asylum, and $250 to the Philadelphia Dispensary.

We shall cherish his memory for the sake of the work he did for chemical science.

He died May 2, 1825, in Paris. The *National Gazette,* July 8th, for that year said of him editorially:

"He was a man of great sagacity and industry and considerable attainments in sciences. He acquired early much distinction as a chemist and mineralogist, not only by very ingenious and valuable experiments but by well-written communications to scientific societies. During the illness of the late Dr. Woodhouse, he coöperated in the delivery of lectures in our University. Exertions were made by eminent men to have him chosen Professor of Chemistry.

" Dr. Seybert represented this city in Congress for eight years. The good sense, knowledge and assiduity with which he discharged his duties as a legislator, and the just propriety and urbanity of his behaviour caused him to be highly esteemed at Washington. He enjoyed the personal friendship of some of the most conspicuous statesmen in the national councils. With his voluminous work ' Statistical Annals of the United States,' for which he collected and arranged the excellent materials during his legislative careers, the American public and Europe are now well acquainted. Credit is due to the author for the preservation of documents so important and for so comprehensive a background of reference on subjects of the deepest interest.

" His friends may claim for him besides an extensive and high reputation in these branches of learning, the character of a moral and upright citizen and of a very understanding and pleasant companion. A few years ago he took a long journey in Europe and brought back a large stack of useful information as the fruit of his travels. It is not many months since he visited France again, this time for the improvement of his health which had been for some time much impaired, but the regular progress and the casual aggravation of his malady proved fatal to him in the French capital, notwithstanding the skill of the best physician and the kind of care of the most respectable circle of acquaintances."

The chemist who loves minerals (and who can fail to do so if he has handled them and sought to learn everything possible relative to their constitution?) will find in reviewing the literature of the early years of the nineteenth century most interesting observations upon minerals. For example, he will read that Henry Seybert visited Haddam, Conn., in the summer of 1823, and while there collected besides other minerals, crystals of chrysoberyl, then "greatly esteemed because of its rarity." He was led to analyze it and to his surprise discovered in it *glucinium.* The recorded analyses of this particular mineral never mentioned the presence of the latter element. Seybert's analysis gave:

	Per Cent.
Moisture	00.40
Titanium oxide	1.00
Glucina	15.80
Silica	4.00
Alumina	73.60
Iron Protoxide	3.38

He had employed "subcarbonate of ammonia" to dissolve out the glucina, and remarked that the iron "on account of the colour of the mineral must be estimated as protoxide."

These results rather amazed him, because they differed from those given by Klaproth for the mineral, and also from those published for the chrysoberyl of Brazil by Berzelius and Arfwedson, so he instituted a study of the specimen from Brazil, which was in his possession, and found:

	Per Cent.
Water	00.666
Titanium oxide	2.666
Glucina	16.000
Silica	5.999
Alumina	68.666
Iron Protoxide	4.7333

The titanium oxide and iron oxide, he said, were "accidental ingredients."

While not an epoch-making investigation it is at least an interesting study. It deserves mention and remembrance. It was a beginning in American chemico-mineralogical research—a forerunner of later splendid studies which won world-wide recognition and were conducted by Brewer, J. Lawrence Smith, Dana, Genth, Koenig, Penfield, F. W. Clarke and his confrères, and others.

Seybert (1822), commenting on the hydraulic lime used in constructing the Erie Canal, mentions the presence in it of magnesia, which had been overlooked by other analysts.

Among other minerals studied by Henry Seybert in this period, were *Bog Iron Ore*, from Monmouth County, New Jersey, and *melanite* from Franklin Furnace; ferruginous oxydulated copper from Lebanon County, Pa. In its analysis he precipitated the copper by iron; asparagus stone from Chester County, Pa.; amphibole—and to the chemist there is this interesting fact in his analysis: After the "silex" was removed, the acid filtrate from it was neutralized with caustic potash; then upon addition of $KHSO_4$ a black precipitate appeared which was filtered, washed and calcined. It was treated with a small portion of nitric acid, exposed to a strong red heat in a platinum crucible, and the residual Al_2O_3 and Fe_2O_3 weighed.

Seybert advised that molybdenite from Chester, Delaware County, is like that of Saxony. It occurs in quartz, often accompanied by pyrite. His analysis, made by the methods in vogue, showed 59.68 per cent. and 59.42 per cent. Mo. It is astonishing how well the analytical work was performed. Would it be an unjust reflection upon Seybert's skill to attribute the concordance of results to a happy balancing of errors? Would it not be better to say that although the methods he employed were in no sense so perfect as those used to-day, the analyst possessed skill and manual dexterity, with excellent chemical judgment, and to these the remarkable results were due?

He also gave the analysis of an American Chromate of Iron (1822), from Bare Hills just outside of Baltimore, Md., where it was amorphous and encrusted with talc. Let us follow the course of analysis:

"The sample was reduced to a very fine powder and exposed to a red heat in a platinum crucible. It weighed 7.87 grams. It was then mixed with 16 grams of KNO_3 and 8 grams KOH, and raised to a red heat in a silver crucible. Time, one hour. The fused mass was treated by water, and the solution, when filtered, was of a bright yellow colour. The matter on the filter was red, it was then treated by diluted muriatic acid, to dissolve the silex which had formed a silicate with the alumine, insoluble in potash. This solution was decanted, and the residue was boiled with concentrated muriatic acid, to dissolve the peroxide of iron. The last solution was filtered and the residue on the filter consisted of that portion of the mineral which resisted decomposition; after being washed and calcined it weighed 3.34 grams. After deducting the 3.34 grams of undecomposed mineral, from the 7.87 grams, there remained 4.53 grams of the *calcined* mineral for the analysis."

This method would not please the exact analyst of the present. Doubtless everyone who reads these lines will recall his own experiences with chromite. Some, too, will remember a stern master remarking that after the melt had been exhausted with water, the residue upon the filter must dissolve quite easily in hot hydrochloric acid, leaving no stain and if anything, nothing beyond a little silica. Seybert's decomposition was incomplete. His sample was not so finely divided as is believed necessary for a complete decomposition.

But let us follow him:

"The two muriatic acid solutions were mixed and evaporated to dryness; the dry mass was treated by water acidulated with muriatic acid: it was then moderately evaporated, again treated by water and filtered. Silex remained on the filter, which, after being washed and calcined, weighed 0.48 gram. The filtrate or liquor from the silex was treated by an excess of caustic potash and boiled during half an hour; it was then filtered; muriatic acid was added to the filtered solution, and by means of ammonium, was found to contain a mere trace of alumine. The residue on the filter, washed and calcined, weighed 2.09 grams; it was dissolved in muriatic acid, evaporated to expel the excess of acid and treated by water; the iron was then precipitated by ferruginous hydrocyanate of potash. The liquor was filtered, the alumine was precipitated from the filtered solution by ammonia, washed and calcined."

Here is that old mode of separating iron from aluminium by means of yellow prussiate of potash. It was employed years before by James Woodhouse for the same purpose. It is recorded in *Buff's Analytical Chemistry.* Meeting it again in this work of Seybert's it was tried qualitatively and found that, in fact, potassium ferrocyanide separated iron, in hydrochloric acid solution, not only from aluminium, but also from chromium and from titanium. The scheme should be studied quantitatively.

The yellow solution resulting from the first fusion of the mineral was saturated by muriatic acid. Alumine was found. It was filtered, washed and calcined.

"To ascertain whether the proper quantity of acid was added to the liquor, a portion of it was rendered slightly acid, and treated by ammonia; no precipitate was formed; it was therefore certain that the acid added had precipitated all the alumine. The liquor was then treated by an excess of muriatic acid, it became intensely brown; chlorine was disengaged, and on heating the liquor it was changed to a beautiful deep green. Ammonia was then used for precipitation purposes."

Those interested in mineral analysis will read this outline of Seybert's with pleasure. To-day we do not adopt his plan in analyzing chrome ore. How many analysts make a sad affair of it notwithstanding our better methods! It is worth while to the student to trace the gradual improvement in our analytical methods. Usually we give these slight consideration, asking merely whether they give good results. The philosophy of a course of analysis is worth study.

Other minerals studied by Henry Seybert were pyroxene and colophonite from New York, a manganesian garnet from Haddam, and a melanite from Tennessee.

The merit of these contributions lies not in the presentation of new and important facts but rather in the skill exhibited by the analyst. Evidently Henry Seybert was extremely conscientious in his work. He repeated his analyses. A single result was not sufficient for him, which recalls the repetition of experiment resorted to by the immortal Faraday. One can almost hear his words, "I repeated the experiment"—seemingly without end. Then, too, if one has studied Klaproth's work the impression will be that Henry Seybert sought to imitate him. Indeed, it was quite a feather in Seybert's scientific cap to find *glucinium* where it had been overlooked by Klaproth, and several of the distinguished Swedish analysts; just as it was a pronounced honor for Klaproth to have found *fluorine* in cryolite when all other analysts had missed it. Similarly, Seybert disclosed, quite independently, the *fluorine* of chondrodite brought from New Jersey.

This very excellent mineral chemist, Henry Seybert, whose work is so worthy of mention, was the son of Adam Seybert and Maria Sarah Pepper, daughter of Henry Pepper, Esq., a wealthy and respected citizen. The mother died during the early infancy of her son, and as a consequence his training devolved exclusively on his father, who ordered his education so that he entered the school of Mines in Paris, where the father had previously studied. Graduating from the same, he returned to "Old

Philadelphia," and earnestly proceeded in his father's footsteps; but, after his father's death, in 1825, he dropped scientific pursuits. This was in part due to the necessity of administering a large fortune; but, being of a roaming disposition, he travelled far and wide. A very fair estimate of him is given by an intimate friend—Madame de Saivre, who wrote:

"During the long period of our acquaintance in France, he occupied himself, at first, a good deal in reading scientific works, and attending lectures on Chemistry and History, but it seemed to me that even then his principal vocation was in doing good. He aided the unfortunate and improvident in their efforts to recover themselves, and lead an honorable existence, and in order to enrich himself to promote this object, I know, established several persons in America; often, also, I have known that he was not repaid money advanced by him to persons who had profited by his confidence and credulity, but were not in haste to repay the money borrowed by them. Nevertheless, he did not weary in being charitable.

"Years ago Mr. Seybert spoke often to me of his studies in Spiritualism, and of a great mission with which he was charged here below. I confess I did not at the time divine what the mission might be. I asked myself only whether *mediums*, more or less sincere, were not abusing his confidence, in order to guide him, after their fashion, in their interests. Though I made many inquiries, Mr. Seybert never explained himself *clearly* on the subject *of this mission*. But now, aided by the knowledge of his last will, I think I understand that beautiful mission which he has made the object of his life, and can inform you what has given rise to it.

"I recollect hearing Mr. Seybert say (I was then about sixteen years old), that he was discouraged and saddened, that he was studying uselessly and seeking vainly the shortest and surest way to save his soul, which, in spite of his efforts, he could not see clearly. He had read in the Holy Scriptures that a rich man could no more enter Paradise than a camel could pass through the eye of a needle, and he was tormented with the thought that all his attempts to lead a good life were useless, as regarded a future life, *because he was rich.* Our poor friend was really very unhappy, and, I recollect, sought conference with our eminent religious men and casuists, and went even to Rôuen to see the Prince de Croy, the Archbishop, on the subject. They all assured him that this sentence was addressed to the *sinful* rich *only,* and not to those who gave of their goods liberally to the poor. In fine, they affirmed to him that *a really good rich man* should *fructify* his property, with the object of distributing it among the poor and needy, and that on this condition only could he be sure of reaching the Almighty after his death. From this moment, dear sir, the vocation of our friend has been fixed. He has lived modestly, even economically, having reference to his large fortune, in order to fulfill here below the Christian mission of the good rich man; that is to say, he has *fructified* (increased) the estate which God has confided to him, in order to be able to bestow more upon those who suffer! Is not this exemplary and magnificent? May we not feel assured that God has already rewarded our friend? As regards myself, I am persuaded that he was drawn into his studies of Spiritualism, by the hope of finding in it some day the assurance that he was in the best of ways—that of charity."

And Mr. Moncure Robinson wrote:

" Peculiar and even paradoxical as Mr. Seybert sometimes appeared to be, he had the high respect and regard of those who knew him well, and during his last serious illness he was not only comforted, but his life, it is believed, prolonged by the thoughtfulness of ladies who sent him delicately prepared food which nourished and sustained him, and without which he would probably have died some months earlier than he did, but which made his more sanguine friends . . . hopeful of his recovery. Although he continued able to drive out daily for some time, and was able to discuss business subjects, as well as all other topics, until within a very few days of his death, he failed gradually but steadily, and his death, which occurred on the 3rd of March following, was anticipated by him."

. . . .

" I met with, some years ago in a newspaper, the following lines, of which I have not been able to ascertain the author, but which seemed to me so applicable to Mr. Seybert that I gave him at the time a copy of them, which will probably some day be found among his papers:

" I slept, and dreamed that life was beauty,
I woke and found that life was duty;
Was thy dream then a shallow lie?
Toil on, worn heart, unceasingly,
And thou shalt find that dream to be
A truth, and noon-day light to thee."

When Henry Seybert died he was the oldest living member of the American Philosophical Society, to which he had been elected three weeks after his twenty-second birthday. Moncure Robinson dwells on this fact; so it may be here incorporated that Robert Hare had been chosen to membership in the same Society just *four days* after he arrived at his twenty-second birthday!

Henry Seybert contributed largely to the mineral collection of the Academy of Natural Sciences to which he gave also 1500 pieces of chemical apparatus and 267 volumes on chemistry and physics.

Father and son wrought well in the cause of chemical science. They deserve the highest respect.

"To the Board of Trustees of the University of Pennsylvania,

" Gentlemen:

" Being mindful of the uncertainty of life at my advanced age, and feeling deeply the importance of making permanent provision for certain interests that seem to me of the highest moment, I hereby offer to your honorable Board fifty First Mortgage Bonds Raleigh and Gaston R. R. Co. ($1000 each) being equal to the sum of Sixty Thousand dollars to be devoted to the maintenance of a chair in the University of Pennsylvania that shall be known as 'the Adam Seybert Chair of Moral and Intellectual Philosophy,' upon the condition that the incumbent of said Chair, either individually, or in conjunction with a commission of the University Faculty, shall make a thorough and impartial investigation of all systems of morals, religion or philosophy which assume to represent the Truth, and particularly of modern Spiritualism.

"I further empower your Board to invest the said sum of money in such securities, strictly legal or otherwise, as may be deemed best, provided that at all times the interest alone shall be expended for the purpose of maintaining the said Adam Seybert Chair.

"I further empower your Board, in case there may be any income arising from the said sum of money over and above the amount required for the salary of the incumbent of said Chair, to dispose of such excess of income in such way as may be deemed best to promote the views I have expressed.

"I have the honor to remain

"Your obedient servant,

"HENRY SEYBERT."

(Copied from the minutes of the Board of Trustees, February 16, 1883. The professorship, above alluded to, exists now.)

Having reviewed the labors of two of the very interesting trio of Philadelphia chemists of the last decade of the eighteenth century, who strove so earnestly to give American chemistry a firm foundation, the labors of the third member, John Redman Coxe (1773–1864), may be scrutinized.

Trenton, N. J., has already been given as his birthplace. On the completion of his medical studies he went abroad to qualify himself more particularly for the Chair of Chemistry which Rush hoped would come to him on the retirement of Priestley. As that never happened, Coxe occupied himself with purely medical problems. He was, despite all he did for chemistry, really a medical man. Medicine was his favorite. He never abandoned it as did his two distinguished contemporaries, Woodhouse and Seybert. For example, he held for several years, beginning with 1798, the position of physician of the Port of Philadelphia.

Shortly after the death of Woodhouse, which occurred in June, 1809, this note appeared in print:

"At a meeting of the Trustees of the University of Pennsylvania, on Monday, July 10, 1809, John Redman Coxe, M. D., was appointed Professor of Chemistry in that University, in the place of Dr. James Woodhouse, lately deceased."

And now it was that his chemical career properly commenced. It was not equal to that of Seybert, or that of Woodhouse. Coxe was more given to theory than either of these. Indeed, soon after (1811) the assumption of his duties he addressed the editor of the *Medical Repository* on the antiphlogistic theory in a rather remarkable way. He declared that neither the phlogistic or antiphlogistic doctrine could be supported in the light of Davy's observations, saying:

"What a glorious era would this have been to the venerable Priestley had he lived to see so many of his controverted opinions consecrated by experience! And how would he now, Antæus-like, have gained strength by the fall, if such, which he received from his powerful opponents!"

One wonders just what views pertaining to theories must have prevailed in the particular year when Coxe penned the preceding sentences. It must not be forgotten that he followed Woodhouse in the Chair of Chemistry, and Woodhouse, it was conceded, had downed the last efforts to establish phlogiston. There must have lingered in Coxe's mind some of the Priestley ideas. These he probably did not teach but did reveal to his intimate friends. His chief purpose, in the present letter, was to oppose the explanation, held out by the antiphlogistonists, of the mode by which iron, etc., is converted into sulphate by the action of sulphuric acid and water. He said, "when water is decomposed by sulphuric acid and iron, its hydrogen escapes but the acid is simultaneously decomposed; and whilst the oxygen of the water combines with the liberated sulphur, and forms an equal portion of sulphuric acid, which immediately dissolves the oxyd. The *original* acid then does not exist." He had evidently been influenced by the writings of Mrs. Fulhame, who discredited, or tried to discredit, both the phlogiston and antiphlogiston views.

Later Coxe published an octavo pamphlet of 50 pages in which he set forth a new theory in regard to acidification and combustion processes "founded on the conjunction of the phlogistic and antiphlogistic doctrines." He presented an ingenious and striking view of the subject. However, the editors of the *Medical Repository* were not prepared to follow him, although they even seemed to have lagged in the train of those who accepted the French teachings. It is not necessary to exhibit Coxe's elaborate argument. It must be accepted that he was theorizer rather than an experimenter. He remarked: "I cannot persuade myself the antiphlogistic doctrines are perfect, or that those of myself are incapable of support." This essay on combustion and oxidation was sharply criticized by Dr. Thomas L. Mitchill in a lengthy article which appeared in the "Memoirs of the Columbian Chemical Society" of Philadelphia, vol. i, p. 174, where the writer remarked:

"When men pretend to reason in science, they should reason as philosophers."

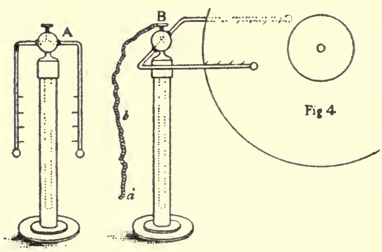
From other contributions, contained in this same volume, there is evidence that the phlogiston idea, though exploded by Woodhouse and others, still lingered in the minds of many excellent scientists, and became the topic of more than one discussion. It was probably the preponderance of speculation throughout the published writings of Coxe on chemical subjects which later called forth the adverse comments of Hare and Silliman, younger men, but true experimentalists. They made no public attack but in their private correspondence alluded to his ignorance of fundamental chemical principles. He undoubtedly read widely, but how much real laboratory work he did is not so evident.

In various places it has been mentioned that Coxe devised a scheme of telegraphy in the early years of the nineteenth century and that it was rather remarkable in character. A search has disclosed that in the *Emporium of Sciences,* in 1812, he published a "description of a revolving Telegraph, for conveying intelligence by figures, letters, words or sentences." It was a purely mechanical device. It was not generally adopted nor does it seem to have received a trial as to its efficiency; although Coxe wrote that he had "constructed a small telegraph upon his plan, about one-sixth the natural size (about 12 feet), that worked readily and appropriately." Others never sought to adopt his suggestion. In speaking of galvanism he said:

"I have, however, contemplated this important agent as a probable means of establishing telegraphic communication with as much rapidity, and perhaps less expense, than any hitherto employed. I do not know how far experiment has determined galvanic action to be communicated by means of wires; but there is no reason to suppose it confined as to limits, certainly not as to time. Now, by means of apparatus fixed at certain distances, as telegraphic stations; by tubes for the decomposition of water and of metalic salts, etc., regularly arranged; such a key might be adopted as would be requisite to another, and so on to the end of the line. I will take another opportunity to enlarge upon this, as I think it might serve many useful purposes; but like all others, it requires time to mature. As it takes up little room, and may be fixed in private, it might in many cases, of besieged towns, etc., convey useful intelligence with scarcely a chance of detection by the enemy. However fanciful in speculation, I have no doubt that sooner or later it will be rendered useful in practice."

An improvement in the plate electrical machine was offered by Coxe. His words were:

" In the plate electrical machine, every one has probably at times found the inconvenience of the usual form of the arms of the prime conductor, which pass on each side of the glass to collect the fluid. There is, moreover, without proper care, some danger perhaps of breaking the glass in removing the conductor; and in a variety of ways it is troublesome. I made, some short time ago, what I consider as an improvement in this part of the apparatus, especially as it can be adapted to every sized plate. It consists simply of a glass rod standing firmly in a loaded foot, on the top of which a cap is fitted of brass, ending in a ball, perforated laterally through the middle. Through this opening a brass rod passes, and is bent on each side, forming two parallel arms about two inches apart. This rod (the arms of it) moves up and down in the opening, but may be fixed at any angle by a small screw at top of the ball. The inner side of the arms are provided with points about half an inch long. Now one of such is placed near edge of the glass plate, and the arms being moved to the requisite situation, the small screw fixes them by pressing upon the rod. From one of the arms, or from the cap or ball at top, a chain passes to the prime conductor, which may thus be suspended from the ceiling by silk, or fixed in any convenient mode. It is evident that, from the motion of the arms, it may, if made of a good size, be fitted to use as well in a small as in a large machine; and when not used, the arms may be allowed to drop laterally, and occupy a very small space in the case for the machine. The following rough sketch will explain the above to your comprehension.

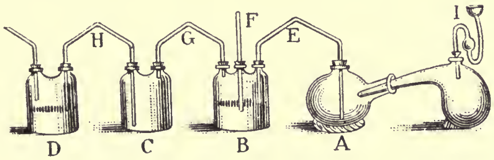


" A represents the machine with the arms shut laterally as placed in case; B, the machine as placed in its relative position on one side of the glass plate, a.b. a chain to communicate with the prime conductor, placed in any convenient situation.

" Having tried the above, I can really testify to its utility, and think it is a very considerable improvement and simplification of this part of the electric machine. It can be set up or removed in an instant; and, being unconnected with the conductor except by the chain, this last may be removed to any distance or situation, so as to guard against accident or danger."

Coxe published in the Annals of Philosophy, vol. i, 69 (1813), his plan of saturating water with gases:

" In places where Welter's tubes of safety cannot be had, such an arrangement of Woulfe's apparatus as will enable an operator to saturate water with the gases, without danger from absorption, cannot fail of being acceptable. The following plan explains such a method, which supersedes the use of Welter's tubes, and will permit the absence of the operator, without danger from absorption.



" The tube E is twice bent at right angles, with legs of equal length; one descends to the bottom of the tubulated receiver, A; the other to the bottom of a three-necked bottle, B. In this bottle is placed the only tube of safety, F, which is necessary, descending about half an inch below the surface of the water.

" The tube G is twice bent, and only perforates the corks, without descending into the bottles B and C.

" The tube H, bent as before, descends to the bottom of the bottles C and D. Other bottles may be added at pleasure, connected as C and D; that is, having the tubes near the bottom of each bottle; or, perhaps, rather as represented above.

"If the apparatus is wanted to saturate water with muriatic acid gas, a little water must be put in B, as usual, to absorb any sulphurous acid gas evolved; C is left empty; and into D, etc., must be introduced the distilled water to be saturated.

"If, during the absence, or from inattention of the operator, an absorption should take place, the water in B will pass up the tube E, and be deposited on the bottom of the empty receiver. When the orifice of the tube F is exposed, the air will rush into the bottle B; and by its presence, if the absorption is great, will force the remaining water into the receiver, until the orifice of the tube is exposed, when the air will pass through the tube E and, rising through the water in the receiver, restore the equilibrium.

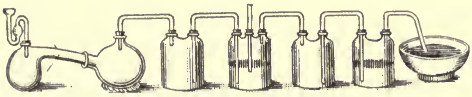
"A part of the water in bottle D will rise simultaneously with the solution in B, and pass into C; but as the tube G does not descend to the bottom, it can pass no farther, and is preserved from contamination by the sulphurous gas in the bottle B. Further, after the orifice of tube F is exposed, the atmospheric air, rushing in through G, arrests the further passage of the liquid of D.

"When an absorption has thus taken place, by exciting a fresh action in the retort, the gas accumulates in the receiver; and when sufficient to support a column of fluid of the height of one leg of the tube E, the fluid in the receiver will be forced into the bottle B again; when the gas will follow and pass into C; when acting on the surface of the liquid that may have come over into it, it forces it back through H into D, and the process of saturation will proceed as before.

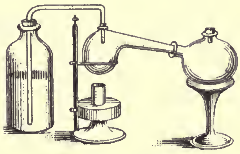
"If a bent funnel is used, as I, the equilibrium is still sooner restored, by the air passing through it at once into the retort.

"In obtaining nitric acid, when the strong acid is desired to be kept unmixed in the receiver, it will be advisable to place an empty bottle between the receiver and bottle B; connecting it and the receiver as B and C; and connecting B with it, as B is above connected with the receiver.

"Since writing the above I have tried the apparatus, I think, very fairly, and find it answers all I could wish. Where, however, the extrication of gas is very sudden and large in amount, it will be best to leave each alternate bottle empty. Thus:



"The gentleman who has improved this apparatus, as described above, has, within a few days, suggested the plan of a self-registering contrivance to send over the acid which may be required in the retort for the decomposition of the materials. This I mean to try in a few days. The plan is simply this: From the tubular of the retort goes a bent tube into a bottle of, say, sulphuric acid to the bottom. When absorption of the extricated gas from the materials in the retort takes place, the atmospheric pressure will force some acid up the tube, and it will pass into the retort; and this will occur as often as the acid is so far neutralized as to



be unable to keep up an adequate action. You will comprehend the intention by this rough sketch—for which I beg you to pardon me, as I am unexpectedly engaged, and must finish this for the packet about to sail."

Coxe also commented on the failure of the pyrophorus in his possession to burn, and said its combustion was due to particles of potassium. This was the view of Davy.

On August 1, 1812, he wrote in "Thomson's Annals" that in 1809–1810 he had mixed equal parts of muriatic acid and alcohol in a vial, "and had left them corked, occasionally opening the vial, to ascertain what change ensued. For several months the muriatic smell prevailed, and I was led to conclude no change would occur; in consequence of which I laid aside the vial, and did not think of it for upwards of a year; on accidentally looking for something else I found the vial: and on opening it was surprised to find a strong etheral smell which still continues. . . . The muriatic smell is gone. . . . This fact . . . evinces that certain actions may not ensue, until after the expiration of a considerable period." Speed of reaction is here indicated, a splendid example.

At the beginning of his letter he remarked "authors have generally considered that muriatic acid and alcohol have little action on each other, except through some complex affinities. . . . I have, however, discovered that *time* is an agent of some importance in producing a reunion, and a consequent formation of ether."

Coxe also expressed himself on "the presumed necessity of atmospheric pressure in certain cases of crystallization." He referred to the "common explanation of a saturated solution of sulphate of soda tied up warm, and rewarming fluid until the bottle is opened, or exposed to such pressure." He was convinced that some other explanation was necessary because he had set aside saturated solutions in uncorked bottles with full air access. He did not suggest an explanation. It interested him very much, so that in 1814 he wrote "Observations on Crystallization" in which he set forth a number of experiments with a variety of salts, adding "in some cases atmospheric pressure seems to operate, in others not; agitation sometimes, but not invariably." He imagined it was somehow "connected with the abstraction of water of crystallization from the regular crystals by the spontaneous, spongy mass."

Practically all of his experimental contributions are embraced in the preceding paragraphs. His day is far past and on pondering these contributions it does seem that Coxe was not to be compared with Woodhouse or Seybert; yet he wielded great influence in "Old Philadelphia."

Reference is made in the "Life of James Woodhouse" to the meddlesomeness of Coxe. He encroached on the subjects of his colleagues so that they were constantly complaining. This and his nagging, carping criticism ultimately caused his removal from the University. He indulged in a most acrid attack upon colleagues and the governing board of the University, but to no avail. He never manifested a favorable opinion of the chemical and physical work of Robert Hare, his successor. He was decidedly pro-English in his political views. Nearly all of his papers were published in English journals. He pushed American periodicals to one side although he edited the "Medical Museum" (1805–1811) and later the "Emporium of Sciences," of which he issued three volumes. This was a most meritorious undertaking, for which he deserves great credit, although one gathers from the letters of Hare and Silliman that they considered him ill-adapted to carry on such a publication, and at intervals called attention to inaccuracies and carelessness in Coxe's writings. Yet, the *Emporium*, or something similar, was needed to correlate the scientific work of our young Republic. The writings of Coxe are always interesting, for he possessed more than usual literary ability.

In 1814 he published the "American Dispensatory"; later "An Inquiry into the Claims of Dr. William Harvey to the Discovery of the Circulation of the Blood"; and "The Writings of Hippocrates and Galen," and was honored not only with membership in the Chemical Society of Philadelphia, and the American Philosophical Society, but also by membership in the Royal Medical Society, the Royal Society of Sciences of Copenhagen and the Batavian Society of Sciences at Haarlan. He lived to four score years and ten, plus one. He died in 1864. What marvellous changes in our science he witnessed! He lived more than twice as long as Woodhouse and almost forty years longer than Adam Seybert.

"Chemistry is of more immediate and useful application to the every day concerns of life—it operates more upon our hourly comforts than any other branch of knowledge whatever" were the words of *Thomas Cooper* (1759–1839), who probably would never be mentioned as chemist by any or at least not by many present-day chemists; but I shall introduce him here and endeavor to tell what I have been able to ascertain in regard to him. He was an Englishman. London was his native city. He was an alumnus of University College, Oxford. He studied law and medicine. He was admitted to the bar, and travelled a circuit for a few years, when he went with Watt, son of the inventor, as a representative of the Democratic Clubs of England to France, where he took sides with the Girondists. He was a member of the National Assembly of France during the period of the "Reign of Terror." His membership was of short duration. "Being of a temper in some degree fierce and fiery, and a spirit fearless, haughty, and uncontrollable, he became engaged in a personal contention with Robespierre, during a sitting of the Assembly. . . . As soon as the session was closed, Cooper, determined on satisfaction for the insult, sought the Frenchman, met him in the street, pronounced him a scoundrel (un coquin), drew his sword, and bade him defend himself. Robespierre declined the combat, but prepared for revenge on the daring Englishman. His design was to have him secretly assassinated." Friends compelled Cooper to leave Paris instantly and he thus had the good fortune to escape the meditated vengeance. On his return to England, he found the public mind greatly agitated, and, called to account for his visit to France by Mr. Burke in the House of Commons, Cooper replied with a violent pamphlet. Finally, influenced by various considerations, he determined to exile himself from his native country, so he came to Pennsylvania, (1793), whither his friend

Priestley followed him in 1794. In 1795 he became a naturalized citizen of the young Republic.

Philadelphia* was then the seat of the National Government, and Congress was in session when Cooper arrived. Washington, Jefferson, Jay, Madison, Elsworth, King and many other distinguished men, statesmen, and politicians were on the spot and in action. And the Goddess of Discord was already among them, and had divided them into Federalists and Anti-Federalists—the former being the advocates of a more concentrated and powerful government, administered and directed by legislators and officers appointed for the purpose; and the latter of a government, with a basis as spacious as the populated portion of the Union, of which every man, who wore a head and wagged a tongue, was in part (and that part far from being inconsiderable) a legislator and an executive agent.

At the head of the Federal party was Hamilton—of the Anti-Federal, Jefferson—and their immediate aids, who consisted of the ablest and most influential statesmen and politicians in the country. Washington, too high, patriotic, and pure-minded to be approached by party spirit, was, as his august title implied, President of the United States.

In this condition of things, strengthened not a little by his own pecuniary condition, Cooper was obliged to look for a subsistence to some public employment connected with the profession of law, to which he had been bred. And that he might the more readily succeed in procuring some appointment, it was expedient that he should attach himself to one of the political parties. Nor was he long in making his choice. Nature and education appeared to have combined in fitting him for many things—but preëminently for three—to be a "liberty and equality philosopher and projector, a party politician, and

* See *Chemistry in America*, p. 141, D. Appleton & Co., 1914.

a political agitator." Hence, he instinctively attached himself to Jefferson and the *Outs*. True, Jefferson was Secretary of State, and therefore, officially one of the *Ins*. But in principle, wishes and resolution, he was an Out; because his object was to supersede Hamilton, oust Washington, or at least prevent his reëlection to the office of Chief Magistrate, and be promoted to his place. And that promotion he expected from the Anti-Federal party.

By several papers which he wrote, and for which he was probably paid, Cooper was not long in convincing his party of his dexterity and strength in the use of his pen, and therefore of his power to aid them in their projects. And to the employment of it, chiefly, as there is reason to believe, he was indebted for his subsistence for several years. The State of Pennsylvania being then democratic in its government, he was at length appointed to a judgeship in it. His tenure of the office, however, did not prove to be either for life or until terminated by promotion. He was an efficient supporter of the administrations of Jefferson, Madison and Monroe, but had violently attacked Adams in 1799, was tried for libel, and sentenced to six months' imprisonment. He served as judge of the Fourth Judicial District of Pennsylvania for eight years, but becoming obnoxious to members of his own party he was deposed from office on a charge of arbitrary conduct. And in 1811, in the month of August, "this stormy petrel" delivered "An Introductory Lecture" on assuming the Chair of Chemistry in Dickinson College, which was really a history of chemistry. Its author gave as partial excuse for following this line of thought that "I am unacquainted with a tolerable History of Chemistry in the English language. It appears to me that the history of an art or science is a proper introduction to the study of it; especially of chemistry." The lecture was published. It covered two hundred and thirty-six pages. Its delivery occupied several hours. A clergyman, a member of the Board of Trustees, knowing that Cooper was at least a Materialist, but familiar himself with chemistry, addressed a letter to Cooper, in which letter, "after noticing the importance of chemistry and its practical utility" he enumerated "the various absurd and impious theories which had been broached on the subject by writers of the infidel school," and reminds Cooper of the splendid opportunity he would have "of inculcating the grand principle of all science." Further, he urged Cooper to deliver a course of lectures "shewing the uses, and ends of the science, pointing out its subserviency to religion, in common with all the works of God." Cooper received the letter kindly, spoke of it as "the production of an able man, and expressed his intention to reply to it." No answer, however, was ever received.

This "introductory lecture" reads well. It is refreshing in style, which is also true of all the writings of Cooper. It was in this lecture that he introduced a very interesting chapter on mineralogy, saying "mineralogy was the hand-maid, the short hand of Chemistry." Cooper remained four years (1811–1815) in Dickinson College. He was its ablest and one of its most faithful and popular teachers. But there came a suspension of college exercises with a change in its government and economy, "and the resignation of some of its officers, and Cooper never returned to it." Before submitting his activities in these eventful years, it will be well to note his course about the period of his impeachment. He spent much of his time in Priestley's Northumberland home, worked in his laboratory and studied in what appears to have been their common library. They were firmly attached to one another. Cooper was not the son-in-law of Priestley, as has often been stated.

The isolation of the alkali metals deeply impressed Cooper. On more than one occasion he carried out the plan pursued by Gay-Lussac and Thénard (1808). He

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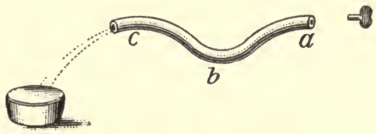
distilled pure potash over, and made it pass through clean iron filings contained in a gun barrel, and exposed to white heat:



" The gun barrel was bent as shown in the diagram so as to go into the furnace. The filings were contained in the bent part, and the two ends came out at apertures in the sides of the furnace. The potash was introduced at *a* and pushed down on the white hot iron filings, where it was decomposed. The hydrogen escaped along a tube represented by the dotted line, the end of which is immersed in a basin of olive oil. The potassium lodges at *c*."

Gratitude is due Cooper for his extraordinary interest in this isolation of the metal, otherwise nothing probably would have been heard of its discovery by James Woodhouse, whose experimental work antedates that of Gay-Lussac and Thénard. Cooper said repeatedly " Dr. Woodhouse procured it (potassium) by decomposing potash by charcoal."

In 1814, while at Dickinson, Cooper gave to " Accum's Chemistry," in two volumes, an American dress. It is replete with highly illuminating notes from its American editor. Students of chemistry would enjoy the perusal or thoughtful leafing-over of this book. In 1815 he published a very exhaustive " Practical Treatise on Dyeing and Callicoe Printing," which should constitute a part of the instructional course of young chemists, particularly devoted to the applications of the principles of chemistry. A casual glance through its pages will reveal its masterly character.

Cooper was especially interested in dyeing. He is said to have acquired his practical knowledge in this direction in France and sought to extend it in England. He alludes to this in an elaborate and illustrated communication on "Bleaching" addressed to the American Philosophical Society in 1817 (*Trans. Am. Phil. Soc.,* i, p. 325), where he remarks on his plan, that he and others had used it as early as 1793, but as the firm was dissolved about the latter year he ventured "to publish it for the considera-tion of those who may have occasion hereafter to bleach with the oxymuriatic acid or its combinations." The source of the chlorine was common salt, oil of vitriol and red lead. He said the process had been "introduced on a small scale into very many private houses in France." The bleaching liquor was passed up through the goods previously deprived of moisture by being run through the squeezers. The acid liquid remained on the goods for twenty minutes.

In 1816 Cooper published an analysis of a blue iron earth of New Jersey. He thought it identical with the blue earth of Jameson and Werner, the fer azure of Haüy, and the fer phosphate of Crochant and Brogniart. It did not contain prussic or phosphoric acid. "It consisted of sub-oxyd of iron, intimately united with about $^1/_{10}$ of the earth of alum, and 24 per cent. of water, probably in chemical union."

In this connection it is interesting to note how Cooper sought to find prussic acid in "the blue stone." He said the test had been suggested and made for him by Joseph Cloud, "who," he adds, "appears to have investigated the properties of palladium more fully than any other chemist." Here is the test; nitro-muriate of palladium and nitro-muriate of gold are not precipitated by the chromate of potash, but they are precipitated by the prussiates (cyanides). "When the red oxyd of mercury is triturated with Prussian blue, and boiled with water for half an hour, a prussiate (cyanide) of mercury is formed, which occasions a fawn-colored precipitate, when added even in very minute portion to the nitro-muriate of palladium: this precipitate is a prussiate (cyanide) of palladium." Red oxide of mercury was mixed with the blue earth in fine powder, and water being added to the mixture, was boiled in a sand-bath for more than half an hour, and constantly stirred during the time; when cool the liquid was filtered and dropped into a nitro-muriatic solution of palladium, but no precipitate appeared.

In 1816 Cooper published a volume of one hundred and ninety pages, entitled "Some Information Concerning Gas Lights." It is a worthy and instructive publication. In it Cooper remarks, "No gas-light system has been yet adopted in America; and therefore I cannot give any result of my own experience on a large scale, although I have been in the habit, during four years past, of exhibiting and burning the inflammable gas from coal and from wood, before my chemical students, as a part of the lecture on the various methods of procuring the carburetted hydrogen gas; all of which were shown, the lights they respectively afforded compared, and their uses explained."

My own impression on reading this book was that of profitable satisfaction.

In the Dickinson period Cooper published in the *Emporium*, 3, p. 491 (1814), "Notes to aid in the analysis of mineral waters," and one of his students submitted a paper on "coloured flames." It was printed in the same volume of the *Emporium*. It related to "the colours of the flame produced by burning cotton, dipt in some of the neutral salts, in spirit of wine."

Cooper assumed the chair of chemistry and mineralogy in the College of the University of Pennsylvania some time in 1816. Just what led to this appointment cannot now be learned. It is barely possible that some of the influence which led to the proffer of the chemical chair of the Medical School to his friend Priestley some years before were still operative and potent. He came at a time when the comparatively new sciences, mineralogy and geology, were calling for consideration, and "Old Philadelphia" was hearing very much about them. Possibly this would explain his early announcement of a course of lectures on this "important branch of Natural History." Having a copy of this fascinating discourse I may be pardoned if I introduce from it a few sentences. For example, Cooper said:

"When a mineral is taken from its natural situation in the earth and transformed into what is called a hand specimen, many of its characters can indeed be determined, but some of its most important ones must be omitted. There is a maxim common in civilized society, which experience has sanctioned, and whose truth is generally acknowledged, 'Tell me what company you keep, and I will tell you what you are.' This is not more true of a man, than of a mineral. It is often impossible to pronounce on a specimen separated from its companions, and transplated from the earth into the cabinet of a collector, while we should decide without hesitation if we saw it in its natural place, in the bed where it was formed, and in the neighborhood of similar minerals exhibiting their natural varieties and gradations: hence the geologic or, as the Wernerians fancifully term it, the geognostic characters of a mineral—the stratum, bed, mass or vein in which it is found—its companions and acquaintances that reside in its vicinity—together with its geographic locality, or country of its residence—are clues to discover the nature of it, in all cases extremely useful, in many, absolutely necessary.

"Moreover, the study of isolated minerals, independent of their natural situations, is the least important, and therefore the least interesting part of the knowledge which the sciences of mineralogy and geology, hitherto improperly divided, are calculated to teach. What with the beauty of many minerals, the delicacy of their colours, the varieties of the crystallization, and other external characters, cabinet collectors are led, or rather misled, to pass without notice the more common minerals, to neglect the great outlines of the science as nature offers them to our view, to confine themselves to minerals, so scarce, valuable and beautiful, and to make a cabinet rather an ornament and a plaything than an instrument of illustration: the chrystallognosts in particular look at a mineral with an eye so microscopic that they seem to merge all ideas of utility in collecting and tracing the form and shape of the mineral they subject to examination, which, when known, is of very dubious utility, unless as an adjunct to confirm, or explain in a few instances comparatively, the indications of other external characters, or the information presented by chemical analysis. It is somewhat like the value set upon a man for the elegance of his person or the richness of his apparel.

"The mode of teaching mineralogy that I have chosen to adopt, is to make it consequent upon, and secondary to, geology. What I want to see is that when our young men travel over any part of this vast continent, they may know at sight the ground they are upon and form a reasonable conjecture of what the earth underneath them contains from the nature of the surface they tread under their feet. It is not pretended that absolute certainty is to be acquired as to all the substance that may be contained in a particular formation or costaneous series of deposited strata; but those who are ignorant of what has already been done would be surprised to find how near to truth a conjecture can in many cases be formed, of what is under the ground, from the appearances upon the surface: and as this kind of knowledge will increase in proportion as facts become more numerous and better registered, it requires little more than to put a student firmly upon the threshold of inquiry to enable him to pursue with effect not merely the investigations of others, but his own.

"It is thus, if at all, that the mineral riches of our country will be gradually searched out and made known; and the inexhaustible source of wealth which the bowels of the earth can furnish to well-directed industry will be laid open for the use of our country. In no other possible way can this be done but by the study of mineralogy, connected with geology, and it is therefore to be ardently wished at least, if it may not be reasonably hoped and expected, that studies leading to an object of such importance will meet with encouragement in a community where they are so strongly required. I have for this purpose endeavored, not always indeed with perfect success, so to form my collection as to show, not only the gangue—the kind of stratum in which minerals are imbedded—but, as much as possible, the minerals found in the immediate vicinity. Had my present ideas occurred to me at first, I should have succeeded more completely by constantly keeping this object in view. But having to search out my own path, without the aid of an instructor and, for some years, far from all the usual sources of information, my notions on the subject were, for a long time, vague and crude. Feeling my own want of elementary knowledge at the outset of my inquiries, I have presumed to occupy the present situation, in hopes of being able to guard others against much waste of precious time, and many errors that so long obstructed my own course of investigation: and without pretending to profound knowledge of the subject, I hope I shall be able to give a little of that assistance to others, which I should have been so glad to have received at the commencement of my own career."

Those who read the "Life of Robert Hare" will have observed in it a communication addressed to the Trustees of the University by Cooper on the importance of chemistry to the medical man, and an insistence that it should find place in his preparatory curriculum; further, an emphatic declaration that the teacher of this science to medical students did not necessarily need to be a person trained in medicine. This fact was alluded to because when Robert Hare, preëminently equipped to teach chemistry, was being considered for the chair of chemistry in the Medical School, there were those who had misgivings as to his fitness, as he had not studied medicine. This was the thought Cooper combated and held up to ridicule. But in the very act of supporting his point he said but if the fact that Hare had not studied medicine was an impediment to his election, then the Trustees might safely select him (Cooper) as *he* had studied medicine and had practiced it! It is a remarkable letter. It exposes marvellous conceit and egotism. In the light of subsequent transactions the Trustees demonstrated wisdom and sound judgment in retaining Cooper where he was and giving to Hare the desire of his heart. Hare and Silliman in their correspondence disclosed a decided antipathy to Cooper, who on several occasions sought to minimize the experimental labors of Hare, especially in the case of his oxy-hydrogen blow-pipe and its astonishing results. In an early letter from Hare to Silliman, the former said:

"It seems my poor little discovery is doomed to meet misrepresentation on every side. T. Cooper, in a late number of the *Emporium*, which he has taken from the incompetent hands of Coxe, says that a degree of heat *nearly* equal to that of the burning glass may be produced by a blowpipe fed with hydrogen and oxygen gases. You may possibly recollect that he *stumpt* me when I was showing the experiments before Priestley by asserting that pure platinum had been fused in an air furnace."

Cooper gave the impression at various times that Joseph Cloud was the inventor of this instrument. How he could possibly hold such an opinion or promulgate such a thought is incomprehensible. It is very doubtful whether Cloud himself entertained the idea. He made several slight modifications, but these were not generally adopted. They had nothing to do with the fundamental principles of the oxy-hydrogen flame.

While active in the University of Pennsylvania Cooper found leisure to issue an American edition (1818) of Thomas Thomson's "System of Chemistry," in four stout volumes, profusely annotated, thus enhancing the value of this work for all American students.

His interest in geology and mineralogy is seen in the following letter:

"Philadelphia, Oct. 31, 1818.

"Sir:

"Mr. Maclure informs me that the public are indebted to you (among many other debts) for the discovery of a secondary Basin at Middleton in Connecticut. I shall begin my course of Geology and Mineralogy in the University here the first week in November; in it I shall give what account

I can of the great Basin of the Mississippi—the Richmond basin—the Paris, London and Isle of Wight Basins, and I shall be glad to mention what is known of the Basin at Middleton, *on your authority.* You will, therefore, oblige me by any brief notice of it you may be pleased to send. If you have any duplicates of the minerals about your place, or from New England generally, I should feel myself much obliged by some specimens, as I am not rich in the minerals of the richest part of our Country. I want a good specimen of your Chrysoberile, and any terminated Tourmaline; and any of the new metalline substances found to the northeast. If you can suggest in what way I can get rid of the obligation by supplying your wants I will gladly do so. Believe me with sincere esteem,

"Your friend and servant,

"(Signed) THOMAS COOPER.

"University of Pennsylvania.

"To

"Dr. Silliman,

"Yale College, Conn."

It is strange, but true, that no trace of Cooper as a chemical teacher has been observed anywhere in the University. A contemporary and colleague of Hare in that institution, there are no evidences of fraternization upon their part. Hare unquestionably felt himself strong enough to carry forward his work, and evidently did not care to confer or consult Cooper on his experimental ideas or plans.

It was in this University period that Cooper contributed quite extensively to the columns of the *Portfolio,* to which he gave the following anecdote of Dr. Samuel Johnson:

"I remember a conversation between Dr. Johnson and Mr. Dagge, during an interval in the performance of Horace's Carmen Seculare, when set to music by Philidor, and performed under his and Baretti's direction. The subject was the proper method of pronouncing the Latin language. Johnson: 'Sir, this is a question that cannot be settled in this day; no modern can have heard the ancients speak; therefore, no modern can tell how the ancients spake; one man may instruct another in proper diction by example, but the instruction must be addressed to the ear, not to the understanding; written precept is insufficient. All we can do in the present case is to conjecture, and of conjectures we are bound by the most probable. That the pronounciation of the Latin would be modified and altered by the intermixture of barbarians, who overturned the Roman Empire, is certain; but in what instances and to what degree is uncertain. It is probable that the immediate descendants of the Romans would be more likely to pronounce the Roman language with propriety than foreign nations. It is probable that persons living in the same climate and on the same spot would be more apt to fall into the pronounciation which a Roman would adopt than any foreigner; for the natural causes that affect pronounciation would be common to the ancient and the modern inhabitant of the same place. For these reasons, I incline to think that the Italians have the chance of being more correct than any other nations. Another observation occurs to me, which, though it will not decide the question, will serve to illustrate the arguments I have employed. When Virgil describes the Cyclops as forging the arms of Æneas, he uses language evidently meant to convey a correspondence of the sound to the sense.

" 'Pronounce this passage like an Englishman, and the beauty almost vanishes; pronounce it like an Italian and it must be felt.' "

His work in the *Portfolio* was done as a means of increasing his finances. He was also honored at this time with the degree of Doctor of Medicine by the University of New York.

He appears to have been in regular and frequent communication with his warm friend and admirer Thomas Jefferson, who consulted him regarding " a university in Virginia which would comprehend all the sciences useful to us, and none others. This would probably absorb the functions of William and Mary College." Indeed, about this time, Dr. Cooper was elected professor of chemistry in the Central College with the understanding that later he was to be in Jefferson's university.

"This appointment of Dr. Thomas Cooper, October 7, 1817—duties to be assumed only when the institution was equipped sufficiently—gave rise as the months rolled by to much unfavorable comment, but when it became generally known that he was to be retained in the University under similar conditions criticism grew pronounced and defiant. No institution can defy the universal denounciation of the clergy of its State, and least of all a new one, like the University, whose creation had suffered already such cantankerous sentiments as to embarrass its promoters. Under the circumstances there certainly was only one alternative—to accept, as the Visitors did, Dr. Cooper's resignation, tendered in full knowledge of the prevailing criticism and in the following spirit: 'I regret the storm that has been raised on my account, for it has separated me from many fond hopes and wishes. Whatever my religious creed may be, and perhaps I do not know it exactly myself, it is a pleasure to reflect that my conduct has not brought, and is not likely to bring, discredit to my friends.'"

It was in 1820 that Cooper left Philadelphia for Columbia, S. C. He became Professor of Chemistry in the College located there; indeed, he attained to the presidency of the Institution. Charles Caldwell, who departed at the same time for Transylvania University, records in his "Autobiography" concerning Cooper, that "we were the first persons that had the independence and enterprise to sever an official connection with the University of Pennsylvania, and issue forth from that medical emporium, for the express purpose of establishing schools of medicine in other parts of the United States. And we were both successful."

In the dual capacity of professor and President, Cooper served the College of South Carolina for a period of fourteen years. He was in almost constant controversy with some one upon subjects of every character, so meeting a sturdy opposition in his Trustees he finally retired in 1834. His connection with the College enabled him to carry out certain projects which were praiseworthy and valuable. He prepared a volume on " Political Economy " for his classes. It is in his usual vigorous style. He promptly installed the natural sciences, which he also taught.

The following unpublished letters written by Cooper in Columbia to Dr. Harlan in Philadelphia carry quite a little interest:

" Columbia, August 22, 1826.

" Dear Sir:

" Last night I received your interesting present of a prepared Brain, and two copies of your reply to Dr. Godman. The preparation came safe and in good order. I feel myself much indebted to your kindness for this preparation, which will be of much use here to others as well as myself. I am desirous of taking every opportunity of examining this principal organ of our nervous apparatus, which, notwithstanding the unintelligible metaphysics of the clergy, I hold to be the only organ of intellect. A review in the *Philadelphia Medical Journal,* edited by Dr. Chapman, and which his good sense ought not to have admitted, gave occasion to the republication of my small tract on materialism. I believe that contributor to Chapman's periodical work was your antagonist, Dr. Godman. If so, I should hold him to be a contemptible bigot and physiological ignoramus. A man pretending to due knowledge of the modern facts and publications on physiology who can abuse others for disbelieving the existence of an immaterial soul, distinct from the body as the source of intellect and mental phenomena, is worse than ignorant.

" I have read with care your reply to Godman and the *North American Reviewer.* It is a pity that the dashing, slashing style of the Edinburgh and Quarterly reviews should be introduced into science. It may do for the quarrelsome squabbles of party politics and metaphysical theology, which that Goliath of the clerical bigots, Dr. Honeley (Archdeacon of St. Albans and Bishop of St. Davids) thought nobody would relish if it were not *for the salt and* *reasoning of controversy,* but it ought not to be introduced into discussions that do not call for the language of vituperation. In this, our new Country, we are too much indebted to the few men who are occupied by the quiet and useful pursuits of natural science to be delighted by anything like ill-tempered remark or any selfish indulgence of sarcasm at their mistakes if they commit any. On a careful perusal of your defence, I think Godman and your *North American Reviewer* are completely answered; and you go far to convict them not only of unbecoming and needless sarcasm, but of ignorance of what has been done and written on the subject they profess to understand so thoroughly, and seem to know so superficially.

"Go on, and pursue your avocation, without heeding what they or any other jealous remarkers may say on the subject. I know that the American public feel obliged to you for your labours, and you may well disregard those who indulge in jealousy of a well-earned reputation.

"Vanuxem, I presume, is now in your city. I am busy printing my lectures on Political Economy, of which, when they appear, I will send you a copy.

"Accept, dear sir, the kind thanks of your friend and humble servant.

"(Signed) THOMAS COOPER."

"Columbia, 21 May, 1827.

"Dear Sir:

"About 10 days ago I received in Charleston whither I went for a few days, the parcel and letter you were so kind as to send me. I set out the next day for this place, and the day after my return I was served with a sore throat and fever, which has confined me to bed; in which situation I am now writing. I am convalescent, but the initiation of blisters on both legs prevents my leaving bed. The Pentamerus fossilshell you were so good as to send, I received, whether Vanuxem means to describe it, I know not, I presume he will write to you unless he delays on account of his visiting Philadelphia next month. I have looked over with much interest your Herpetology, but I am not master of that branch of natural history, and receive it rather as a mark of your kind attention than to profit by the knowledge it contains.

"I have been perusing with care lately Gall's late work on the functions of the Brain and on Phrenology generally. His physiological and anatomical views, appear to me, for the most part, unanswerable: I cannot say the same of his distribution of organs, and their localities. These depend on the evidence of induction of facts; and one observer is not sufficient authority to ground these facts upon, nor two or three or four; more especially as there is manifestly a mingling of very fanciful hypothesis in the assignment and division of them.

"I wish I could get a translation of such part of his work printed, so far as I regard the steps of his road made firm and endurable; so as to fix a resting place, from whence future inquiries may set out. I would translate as much as would serve this purpose, which would occupy two common 8vo volumes; but there is no such thing as getting it off one's hands in this country, altho' the labour of the work should be given away. But with us

> "'Many an enterprise of great pith and moment
> With this regard its current turns awry,
> Losing the name of action.'

"I hope your labours will not only be honourable and useful, but profitable also. Adieu, dear sir, and believe me your friend and humble servant.

"(Signed) THOMAS COOPER."

"To
"Dr. Harlan,
"Philadelphia.

"I put up a copy of my Pol. Ec. for you to be sent from hence in the box to Carey & Co. If you have not received it, I will direct one to be sent to you."

While in Philadelphia Cooper suggested the following mode of detecting arsenic:

"Take a piece of a pane of glass. Put on it the 16th part, for instance, of a grain of white arsenic, or any portion of a grain that may be distinctly visible by the naked eye; on another as much corrosive sublimate; on another as much sulphate of copper: drop on each one or two small drops of chromate of potash, whereof the excess of alkali has been neutralized by nitric or acetic acid, according to the usual process of the manufacturers of chromat of lead. In a minute the copper will give a distinct brown tint; the corrosive sublimate an orange; the arsenic, after three hours, a decided green.

"The arsenious acid or white arsenic, attracts oxygen from the chromic acid, which is thus converted into a green oxyd and precipitates; the alkali combines with the acid of arsenic. This appears to me the easiest method of procuring the green oxyd of chrome. (I strongly suspect the Columbium to have been a chromat of iron.) Thus, the chromat of potash furnishes a test for the three substances, usually employed as poisons."

Evidences of activity in the science of chemistry, during the Columbia period, are wanting; so the writer may be pardoned if he closes his sketch of this particular chemist of "Old Philadelphia" with impressions gathered by gleaning wherever possible, the expressed and divergent views regarding this interesting but singular man. He was an eager, restless spirit, always anxious to take part in everything of moment which was passing around him. He was an opportunist—not a pioneer. He was wonderfully facile in taking hold of the thoughts of others. He was in no sense originative. He was preeminently practical, a utilitarian, measuring everything by its temporal value. The present was to him everything and the future a dark void. His philosophy was shallow. He was not a great generalizer and his reasoning was never carried to a finality. Those who knew him best declare that his largest attainments were in chemistry. He knew the cognate sciences and was versed in the law, medicine and Political Philosophy. He revelled in wonderful personal experiences. He had associated intimately with the most remarkable men of the old and the new world. He knew Fox and Pitt, Sheridan, and Erskine and Burke. He was an admirable talker and a fine table companion. There are those who say he was in religion a Unitarian as was his intimate Dr. Priestley, while others think otherwise and say, not in a spirit of condemnation, that Cooper " drank deep of the fountain of infidelity. He read the Bible, whose authority he openly derided and prayed to a God in whom he did not believe." He was a kind neighbor and as a husband and father was without fault.

He was a prolific writer, which is attested by the fact that he published " Letters on the Slave Trade," 1787; " Tracts, Ethical, Theological, and Political," 1790, among which are to be found " Tracts on Materialism and an Outline on the Association of Ideas "; " Information Concerning America," London, 1794; a collection of political essays reprinted from a Philadelphia newspaper in 1800; " An Account of the Trial of Thomas Cooper of Northumberland," 1800; " The Bankrupt Law of America Compared with that of England," Philadelphia, 8vo, 1801; a translation of the " Institutes of Justinian," 1812; a work of " Medical Jurisprudence," 1819; two of the five volumes of " Emporium of Arts and Sciences," Philadelphia, 1812–14; " Lectures on the Elements of Political Economy," Charleston, 1826; " Observations on the Writings of Priestley "; two essays, " Foundation of Civil Government," and " On the Constitution of the United States," 1826; and many vigorous political pamphlets. He translated Bozussais' " On Irritation and Insanity." He was an ultra State-rights man.

Remarkable and strange character as Cooper undoubtedly was, he did promote the interests of our science in " Old Philadelphia " and in the young Republic, so that while he was the storm center of much adverse criticism in practically every circle in which he moved, we are assured that he was a good man, therefore this outline of his career may well close with the lines:

" ' In men whom men condemn as ill
I find so much of goodness still,
In men whom men pronounce divine
I find so much sin and blot
I do not dare to draw a line
Between the two, where God has not.' "

When, in 1809, James Woodhouse passed away, the Chemical Society of Philadelphia ceased, having lost its founder and sole president. Interest in our science, however, continued, and in 1811 there came into existence the Columbian Chemical Society. On its membership rolls may be seen the names of many members of the older Chemical Society of Philadelphia. It should ever be remembered that these two Societies were the first of their kind in the world. There is recorded knowledge of none earlier. It is highly gratifying that the City of Brotherly Love should have been foremost in this field of literature. The real interest of many of its inhabitants in chemistry was the primary reason for this activity. The fact should not be allowed to escape notice. The Columbian Chemical Society made it a point to publish annual proceedings, for at least one such volume appeared in 1813. Often as the writer has mulled through the pages of this priceless book he never fails to detect some new thing worthy of thought. The book is very rare. Perhaps a search in garrets of old homes, or in the dark places in old libraries might bring to light copies whose existence hitherto was not suspected.

Again, it was about 1812 that the dominant chemical thought of "Old Philadelphia" changed.

Turning a moment to the labors of Adam Seybert it will be remembered that, in Paris and in Germany, he received an impulse to mineralogy; that on return home he established a shop in North Second Street where he gave strictest attention to chemistry and mineralogy; that he devoted his chemical skill to unravelling the composition of minerals; that as a mineralogical chemist he towered above his contemporaries; that, in short, he was giving a new bent to chemical investigation. All this was most inspiring, and now, in 1812, there came to "Old Philadelphia" another ardent lover of nature, a chemist who, in Paris, had experienced the privilege of association with the immortal Haüy and, under his pervading influence, had applied his chemical knowledge and skill to minerals. It was not only chemistry which he brought to bear upon the latter, but also crystallography, acquired from Haüy. This line of attack had not been mentioned by Seybert.

And on reviewing the eminent mineralogical chemists and mineralogists who made this city their home and the scene of activities which drew to Philadelphia through many years most eminent scientists from abroad, to whom the fame of our mineralogical collections was known, surely the period of the new departure in chemical aim and purpose must be designated epoch-making—a new era!

And the particular individual, responsible for the promulgation and development of the new trend in chemical thought was Gerard Troost (1776–1850), a native of Holland, who was educated at Leyden, from which University he received the Doctorate of Medicine, and at Amsterdam, where he won the degree of Master of Pharmacy. He is said to have been a real genius. At the same time, he was a most lovable man who, knowing the world, was yet a profound scholar without pedantry, eloquent, and a wit and humorist. As a consequence of the patronage of Holland's King he had been able to study in Paris, where contact with Haüy won him to the mineral side of chemistry, to which he most assiduously devoted himself. He also travelled through France, Germany, Switzerland and Italy, embracing every opportunity to advance himself in his chosen field. Contemplating a trip to Java, *via* this country, but delayed on his arrival in Philadelphia by unforeseen circumstances, he concluded to remain in this country, becoming a naturalized citizen as soon as possible. Indeed, he married here in 1811. His children were born in this city.

Happy and eager to be of service, he soon gathered about him many of the young scientists of the city, and there was founded by them the Academy of Natural Sciences, of which he became the first president. In this new Society, the greatest activity prevailed. It will be recalled that this organization had purchased Adam Seybert's mineral collection as early as 1813. The membership of the Academy included all the members of the two early chemical societies. For five years Troost was the guiding spirit of the Academy. He also assumed the duties of the Chair of Chemistry in the Philadelphia College of Pharmacy. As early as 1811 he engaged in the manufacture of alum from the pyritic and lignitic Cretaceous clays found at Cape Sable, Md., thereby establishing the first alum manufactory in this country, although, sadly enough, it proved for him a disastrous financial failure.

In 1828 Troost published a "Geological Survey of the Environs of Philadelphia." All interested in this particular subject will pronounce this brochure a genuine classic. Reading it quite recently the writer found it difficult to lay it aside until every line had been read. All who have studied the mineralogy and geology of Philadelphia and its suburbs will find this a sure guide. They will travel over their old haunts in the company of him who first blazed the way, and a new zest for such pursuits will be aroused.

It was in 1828 that Troost took up the professorship of chemistry in the University of Nashville. There he conducted a grand piece of work, becoming as the years progressed more and more of a paleontologist and geologist. To-day he is revered in the Southland, and the geologists of America are eagerly according him a place in the first ranks of their own guild—but, this story belongs to another activity.

In studying the chemico-mineralogical contributions of Gerard Troost one is impressed with their thoroughness. His conclusions have lasted. His analyses of minerals were of a high order. He constantly resorted to crystallographic measurements, employing the best reflecting goniometers. He continually emphasized the necessity of attention to crystalline forms as exhibited by minerals and particularly by minerals of this country, "many of which have no analogies with those described by European crystallographers." Thus he said (1821) of a phosphate of lime found at St. Anthony's Nose near New York, "the crystals are sometimes so much flattened or compressed as to put on the appearance of an eight-sided table with bevelled edges"; that the zircon crystals, found on York Road near Philadelphia, exhibited very great modifications of the usual and well-known forms; that there were distinct, new forms on apophyllite, automalite and amphibole, as well as on the quartz from Lake George, and upon the sulphate of strontia from Lake Erie, and the andalusite of Litchfield, Conn. By most careful crystallographic measurements he demonstrated that Keating's *Jeffersonite* was really not a new species but a *variety* "of the proteus of mineralogy—pyroxene." His account of the latter, published in 1823, is in many respects remarkable from a crystallographic and chemical viewpoint. It reflects great credit on its author, who further wrote (1823) upon *Yenite* or *Lieverite* from Rhode Island, saying it was the first time this mineral had been observed in the United States. In the year following (1824) he noticed in detail the first *petalite* found in America, finding it associated with actinolite and mistaking it at the beginning for tremolite. It was in this year (1824), too, that he studied the crystallographic nature of chrysoberyl coming from Saratoga, N. Y., and taken from the cabinet of Mr. Joseph Cloud. It exhibited quite new forms.

Too much emphasis cannot be laid upon this pioneer work of Troost. It was chemical, mineralogical and crystallographic in nature. The studies were direct, clear and most convincing. They have borne the test of time.

William H. Keating (1799–1840) was the second mineralogical chemist in the College of the University (1822–1828). He was a native of Philadelphia, and a son of John Keating, a baron of France, who, at the outbreak of the French Revolution, came to America and settled here. After receiving his baccalaureate degree from the University (1816) William H. Keating continued chemical studies in particular in the polytechnic schools of France and Switzerland.

It was in his first year at the University that he established in the College a working chemical laboratory, and soon thereafter announced the new mineral Jeffersonite, after analyzing and measuring it crystallographically. He thought he had sharply differentiated it from pyroxene as he found in it an abundance of manganese and an absence of magnesium. Later Troost proved conclusively, as already stated, that Jeffersonite was merely a variety of the variable pyroxene.

Torrey had announced a new mineral from Columbia County, N. Y., which under the eye and tests of Keating proved to be (1822) an artificial zinc oxide.

As a founder and active spirit in the Academy of

Natural Sciences Keating frequently met Vanuxem, with whom he prosecuted a dignified series of studies on the minerals and geology of Franklin, N. J. Thus, as new minerals they announced *red zinc ore,* franklinite, dyslusite, zinc carbonate, calamine and automalite from that locality. Indeed, the whole number of minerals met there by them was thirty, "among which eight or ten present new varieties." The keenest interest is aroused by the perusal of this paper.

Literary remains of Keating are not numerous. He ventured upon an American edition of "Conversations in Chemistry," and in 1825 issued a "Narrative of an Expedition to the Source of St. Peter's River," in two volumes. It contained much information concerning the Indians, while the botany and geology were worked up by Say, and Keating contributed the geology. In brief it was a compilation of the notes of those who participated in the expedition. It is a most readable book of travel, observation and adventure. It occupied two volumes and was inscribed to President Monroe, under whose administration the expedition was undertaken.

Keating married the daughter of Eric Bollman and granddaughter of Colonel John Nixon.

He was a man of great scientific attainments and gave much attention to public matters. He was one of the founders of the Franklin Institute, a State Legislator and one of the originators of the Philadelphia and Reading Railway.

The platinum metals have always proved a knotty problem for chemists when their separation from one another has been involved, yet in 1809 Joseph Cloud, smelter of the Mint, wrote on this subject. He seemed to have for his purpose demonstration of the fact that when the native ore—that from South America—was opened up, the isolated "rhodium in its uncombined state, and in some of its combinations with other metals, is insoluble in nitric and in nitromuriatic acid," and continues, " it is particularly remarkable, that it should be stable in its native combination with native platinum, and become insoluble in the artificial compounds " it may afterwards enter. His explanation is " that the platinum, palladium and rhodium, in a state of nature, were in *perfect* chemical combination; the effect of reciprocal attraction. That is, the different metals were united together so intimately by chemical affinity, that each integral particle consisted of the same principles, combined in the same relative proportions, as in the general mass, united by the force of aggregation. . . . There are numerous examples in chemistry, in which aggregation in bodies is so powerful that they are not sensibly acted upon by others, even in the fluid state; though the combinations of them are affected when the aggregation of the solid is destroyed: the native oxide of tin resists the action of any acid. The apparent insolubility is owing to its strong aggregation; when this is overcome by mechanical operations, it becomes soluble," and he concluded:

" As an humble labourer in the science of analytical chemistry, I, with much diffidence, submit these theories to the public eye."

It was Cloud, also, who occupied himself quite a bit in ascertaining the fusing points of metals, and in addition sought the causes why metals in a solid state appear to be specifically lighter than they are in a state of fusion, saying:

" The metals, in a state of fusion, do not operate as mere conductors of heat, but their particles, being considerably separated, like all other fluids, permit the caloric to pass in an uninterrupted current between them without being subjected to the tardy and progressive conducting powers of the solid metal. The heat thus passing through the fluid metal, with increased facility, and striking the under surface of the unfused metal, will become subjected to the conducting powers thereof, and consequently be retarded in its progress."

It will be recalled that Cooper sought to ascribe to Cloud the invention of the compound blowpipe. Perhaps the remarkable skill of Hare and his wonderful insight which led to his finding the oxy-hydrogen flame, with its astonishing results, touched somewhat the pride of older chemists in this vicinity, and like others farther removed, in the frailty of human nature, they imagined that at some time they had entertained similar thoughts.

Cloud was an earnest chemical student. Problems which entered his field of observation were quite likely to have his serious attention. He was a decided promoter of chemical science in this locality, indeed he had an honorable share in finally establishing the individuality of palladium, for there were "doubts with respect to the existence of such a simple substance." Many thought palladium was only an alloy. Cloud, having obtained it not from platinum mixtures, but from an alloy of gold and palladium, isolated the latter and discovered it to be identical in all of its reactions with the metal which Wollaston announced in 1803 as new, under the name of palladium. He devised a contrivance for preparing mineral water. His friends Eckfeldt, Cooper and R. M. Patterson were much pleased with it.

Cloud's papers are thoughtful and give evidence of wide knowledge in chemistry and skill in experiment. The writer has been at great pains to learn something about him, particularly as to where he was educated in chemistry. All that could be gathered by inquiry, and by searching books and serial files of scientific volumes was that he was born in 1770 and passed away in 1845. He was a great-grandson of William Cloud of Calne, in Wiltshire, England, who purchased land afterwards laid out in Concord Township, Chester County, Pa., at the close of the seventeenth century. Nothing was found relating to his youth and training. It was in 1797 that he assumed his position as the head of the melting and refining department of the United States Mint and retained it until 1836, when he resigned the office because of defective eyesight.

He married the daughter of Enoch Taylor. Their only son was Joseph, Jr. (1800–1834), who graduated in medicine in 1823, and " whose education was conducted principally beneath the paternal roof. . . . The best masters in the various branches to which his attention was called, were selected, and he enjoyed every facility which the great anxiety of his father to render his education complete, could suggest."

This care in his son's education marks Cloud as a wise man. The son seems to have acquired scientific tastes and in later life founded in Media a scientific society called " The Cabinet." Before it he appeared frequently as lecturer.

Failing in search for additional data relative to Cloud, Sr., old local newspapers were scanned with a single result, viz., that in the *Public Ledger* for August 2, 1845, appeared these lines under *Died:*

> " At his farm in Delaware County on Thursday evening, July 31, Joseph Cloud, Esq., in the 75th year of his age.
>
> " His male friends, and those of the family, are respectfully requested to meet his funeral at the dwelling of Adam Eckfeldt, Esq., in Juniper Street, near Vine Street, this afternoon at 5 P.M. without further notice—to proceed to Monument Cemetery."

And at a meeting of the American Philosophical Society held August 15, 1845, this resolution prevailed:

> " On motion, Mr. Eckfeldt was appointed to prepare an obituary notice of Mr. Cloud."

From this it seemed to the writer that at last he was to have an intimate sketch of Cloud about whom he had long thought, so leaf after leaf was patiently turned to meet:

"At the stated meeting of the American Philosophical Society on November 7—"On motion of Dr. Patterson, Mr. Eckfeldt was excused from the duty of preparing an obituary notice of Mr. Cloud."

Fond expectations were again shattered!

The Cloud farm, in Delaware County, lies back of the present University Astronomical Observatory. It became the property of his friend Adam Eckfeldt.

Cloud was a scholar and a profound thinker. He was a member of all the local scientific bodies and was active in them. Pure chemistry was his favorite, though he exhibited deep interest in all the changes which were made in the science. He, no doubt, often thought:

"My heart is awed within me when I think
Of the great miracle which still goes on,
In silence round me—the perpetual work
Of the creation, finished, yet renewed forever."

Towering above—overshadowing, indeed—the splendid men whom we have learned to know was one, many of whose efforts influenced the present and in many instances continue to influence the present. This individual was Robert Hare (1781–1858). Recently his life story has been exhaustively rehearsed and its chief parts are familiar to many who read these lines, so that a résumé will suffice.

Not yet of legal age, he gave to the world in his compound blowpipe and the oxy-hydrogen flame discoveries wide-reaching in their effects. In his calorimotor and deflagrator he provided chemists and physicists with new and powerful sources of electric energy. To him we owe the first electric furnace, "promptly forgotten and re-invented many years later." He gave us artificial graphite, pure charcoal, calcium carbide, etc. "Hare was in many respects the precursor of Moissan, though a much more brilliant man than the latter." . . . "If we call Moissan the Christopher Columbus of the electric furnace, we must call Hare the Leif Eriksen of the same." He was also the inventor of the mercury cathode, which now plays so important a rôle in the electrolytic manufacture of alkali and its by-products. And, Dr. Doremus has well said, "Another of Hare's most important contributions to general welfare was his 'rock-blasting' apparatus . . . where by the use of a 'plunge battery' . . . a wire is brought to incandescence, and thus becomes the means of igniting gun powder, or other explosive, and this at any distance, under water, or practically any condition. As one looks around New York to-day and wonders at its sky-scrapers, its magnificent bridges over deepened waterways, its underground tunnels, its tunnels beneath the rivers, its splendid water supply brought from the Catskills, under three rivers, and finally the Narrows to Staten Island, an engineering operation second only to the construction of the Panama Canal, how little we realize our indebtedness to Hare and his 'rock-blasting' device!" He was indeed a pioneer in gas analysis. His ability and profound interest in the nature of energy and the constitution of matter are shown in his controversies with such masters as Berzelius, Faraday and Liebig. He was in truth a profound chemical philosopher. Much more than what has been cited emanated from him, but people were not interested in such things then. Hare was born too early. His career was fascinating and marks him as one of the world's leaders in chemical and physical research.

A photographic composite of early Philadelphia chemists would be most interesting. Priestley, Woodhouse, Adam Seybert, Cooper, Coxe, Joseph Cloud and Hare were undoubted experimentalists in pure chemistry. Adam Seybert, his son Henry, Troost, Keating and, to a degree, Cloud were mineral chemists. Chemistry was the instrument by which they disclosed the composition of the products of Nature's laboratory. Priestley, Woodhouse, Hare and Cloud were natural researchers. De Normandie, Woodhouse, Adam Seybert, Cloud, Henry Seybert, Troost and Keating were superior analysts; Rush, Woodhouse, Coxe, Cooper, Troost and Hare were great teachers. Rush and Adam Seybert entered Congress. Keating sat in the Legislature of his State. Priestley, Cooper and Troost were foreign born. Priestley and Cooper were radicals and lovers of controversy, while Troost cared only for science and its peaceful ways. Each made his contribution to chemical science in this country and in "Old Philadelphia" and well deserves the title of pioneer. As such their works will ever command the highest respect.

A persistent curiosity to ascertain what chemical texts were studied by the chemists of "Old Philadelphia" has resulted in showing that the works of Boerhaave, Lavoisier, Joseph Black, Scheele, Chaptal (translated by Woodhouse), and Thomas Thomson (edited by T. Cooper) were without question most familiar guides, but with them should be included also the following publications:

"A Chemical Syllabus," by John Vaughan, M.D., in 1799, which he addressed, in a preface to the "Philosophical Society of Delaware" in these words:

"Fellow Citizens:

"In reflecting on the important and difficult task you have assigned me of exhibiting to the public a course of experiments on Chemical Philosophy under your auspices, one of the greatest obstacles that presents itself is the diffused state of chemical phraseology. For the purpose of removing this impediment, in some measure, and of rendering this beautiful science familiar to men of business, who have not leisure to wade through volumes, I have collected a syllabus of the chemical nomenclature—which I request you, and them, to accept as a tribute of respect."

A perusal of this diminutive volume indicates that here in America there was spreading a genuine desire for a close acquaintanceship with our science. The desire was permeating all professions—even business: just as to-day—in the moment of the world's extremity—men look to chemistry, to what it can produce, to bring about a better state of affairs. Then, too, there is observed a wish to promulgate the nomenclature of Lavoisier and his co-laborers. Said a review: "It is justly the boast of modern times, that science descends from the chairs of professors and from the pages of precious volumes, assumes every shape, and accepts every station, in order to accomplish the great end of public instruction and utility."

An American edition of "A Chymical Catechism," by S. Parkes, manufacturing chemist, appeared in this city in 1807. It is a remarkable book. It contained an outline of about 154 experiments, which is another evidence of the appreciation of experimentation. Students may talk, hear and see, but an intimate acquaintance could only be got by personal experiment:

> "Thus, at thy potent nod, *effect* and *cause*
> Walk hand in hand, accordant to thy laws;
> Rise at Volition's call, in groups combined,
> Amuse, delight, instruct and serve mankind."

A reviewer said of this book:

"It is written in an elegant and popular manner, and rendered as amusing as it is instructive."

Another production to which frequent reference was made by early Philadelphia chemists was:

"Chemical Essays," by the Rev. Dr. R. Watson, F.R.S. It was regarded by them as authoritative and constituted a portion of the chemical pabulum upon which they were nourished. The author was Regius Professor of Divinity in the University of Cambridge. He presented his material in a very attractive form, and treated exhaustively the various topics. The work ran through many editions.

Henry's "Elements of Chemistry," which appeared in the early years of the nineteenth century, was another English product and a favorite with our chemical fathers. American editions of it were published by Robert Hare, and subsequently by Benjamin Silliman, although when these two scientists issued their own independent texts there was no evidence that they had been impressed unduly by the work of Henry, although it is still very attractive and does most certainly present more than the elements of our science. The book was originally dedicated to John Dalton "as a testimony of respect for the zeal, disinterestedness and success with which he has devoted himself to the advancement of chemical philosophy." There are two volumes. In the first, the doctrine of the chemical atomic theory is presented in great detail. The work of Richter and Wenzel is fully recognized, although the part played by Proust in establishing the law of definite combinations "by showing that iron and antimony do not unite with oxygen in all proportions, but only in very few determinate ones" is not especially emphasized. There is also a very complete chapter in the second volume of the book devoted to chemical analysis. Its perusal develops high respect for the pioneers in this particular domain. Modern chemists seem not to appreciate how slowly and with the expenditure of how great mental effort analysis has been built up. Sometimes graduate students are eager to study an epoch-making research, *e.g.*, Bunsen's work on Cacodyl, Wöhler and Liebig on Benzoyl, v. Baeyer on Indigo. This is done that they may gain inspiration for the undertaking of a similar task, and in order that they may learn how great problems are solved. Surely, anyone seeking to understand how we came into possession of our present admirable and exceedingly complete *analysis* will find it by following the chronological development of this special field. In his pursuit he will pause many times, wonder and admire the efforts given to the solution of the almost innumerable knotty problems.

In those early days the best quantitative means of separating barium from strontium consisted in the removal of the first with potassium ferrocyanide, etc.

It should be a source of pride and gratification to us that our forefathers had no small share in the perfection of these analytical schemes.

In 1810 the first American edition of "An Essay on Combustion," by Mrs. Fulhame, made its appearance in Philadelphia. It is a remarkable book. The American editor did not give his name, but the tone of the preface suggests Thomas Cooper. The following paragraph reminds one of him:

"Whether it be that the pride of Science revolted at the idea of being taught by a female I know not; but assuredly, the accomplished author of this essay has sufficiently evinced the adequacy of her requirements in the promulgation of opinions subversive of a part of the highly esteemed edifice raised by Lavoisier and others."

And these lines ostensibly were penned because the book "published so far back as the year 1794" had received little notice, for he continues:

"That the work has hitherto remained unknown in this favored land [this recalls Cooper], where freedom of inquiry is so sedulously cherished, is a matter of surprise;

especially when it is known that many years past the author was elected an honorary member of the then-existing Chemical Society of Philadelphia, a distinction founded on the merit of this work; yet the doctrines here advanced appear to have been known to but few individuals, for they have never been comprised in lectures on Chemistry, which are given in various parts of the Union, etc."

This book, which must have vexed those Americans who strove to eliminate the Stahlian ideas maintained by Priestley, and to establish the views of the French School, contains on the final page the gist of the whole of Mrs. Fulhame's argument:

"1. That the hydrogen of water is the only substance that restores bodies to their combustible state.

"2. That water is the only source of the oxygen, which oxygenates combustible bodies.

"3. That no case of combustion is effected by a single affinity.

"This view of combustion may serve to show how nature is always the same, and maintains her equilibrium by preserving the same quantities of air and water on the surface of our globe; for as fast as these are consumed in the various processes of combustion, equal quantities are formed and rise regenerated like the Phoenix from her ashes."

Mrs. Fulhame evidently experienced unpleasantness in the rôle of chemist, for she wrote:

"It may appear presuming to *some* that I should be engaged in pursuits of this nature. . . . Censure is perhaps inevitable, for some are so ignorant that they grow sullen and silent, and are chilled with horror at the sight of anything that bears the semblance of learning in whatever shape it may appear; and should the *spectre* appear in the shape of a *woman*, the pangs which they suffer are truly dismal."

John Redman Coxe published in 1818 a translation of the "Practical Chemistry" of Orfila. The translator announced in his preface that the book was virtually an abridgment of a much more extended work by Thénard.

Coxe thought it "a no small means of facilitating this interesting branch of science." Among topics discussed there is "an epitome of the measures to be pursued in the analysis of the different objects of research." When one remembers that in 1818 very little had been done in the way of assembling methods of analysis this publication acquires special interest, particularly as one reads the schemes used in analysis by the earlier American chemists who never enjoyed European training. It may have been the first attempt to educate American chemists in the analytical field. Readers may have smiled on reading Woodhouse's course of analysis with minerals, and even with Henry Seybert there lingered very primitive analytical methods. How astonishing it is that these did have a real value! Buff, in Germany, published in two volumes (1820) the first analytical chemistry of any worth and pretension. It may have been the pattern for Heinrich Rose. Such thoughts come to mind in studying these volumes. It must be remembered also that before Buff, Lampadius offered a very meagre and incomplete volume on analysis, which was, in no wise, comparable with the books of Buff. Pardon the digression; it has been made to emphasize the fact that in this translation by Coxe there is probably, as already stated, an effort—the first, perhaps—to give young American students of analysis a guide to direct their endeavors in this interesting branch of chemistry.

The contents of the entire volume are very meritorious.

The elementary or simple substances are described under the headings "simple *not metallic* and simple *metallic* substances." In the first class are oxygen, hydrogen, boron, carbon, phosphorus, sulphur, iodine, chlorine and nitrogen. There are six classes of metallic substances. Air is discussed first, then come the combinations of the simple non-metallic bodies amongst themselves—oxides, acids, etc.

In this volume of Coxe appears the name phtorine for fluorine, a new designation for the latter, and one reads throughout the text of phtor-boric acid, phtor-silicic acid, calcium phtoruet, etc., etc.

Perhaps in chemical conferences early chemical texts might be studied with profit and with pleasure. In our busy, exacting instructional duties we become restive upon mere mention of the past. Nevertheless, it affords an endless fund of inspiration, helpful surely, particularly to those whose task it is to develop the minds of the youth of the present.

One of the most popular treatises on Chemistry which ever appeared was "Conversations on Chemistry." It was the work of an English lady. It passed through many editions in its native land. Here in America there was published edition after edition, under the editorship of quite a number of gentlemen. For example, the ninth American edition from the eighth English was from the pen of Dr. J. S. Comstock (1826), although two years before (1824) W. H. Keating, Professor of Chemistry in the University of Pennsylvania, had sent out the tenth American edition from the eighth English edition on the basis that "the success of this useful work is the surest proof of its merits." Doctor Comstock also edited the thirteenth American edition of this book. It would seem that originally it was particularly written for "the female sex." Those of that sex who used the book certainly received more than a "smattering of the science." Anyone caring for chemistry will profit by studying this little book, ancient as it now is. It might well be expected that Thomas Cooper would not refrain from commenting on this highly esteemed publication; therefore it is not surprising to learn that he issued the fifth American edition (1818) in two volumes. In his introduction he said the "Conversations on Chemistry, usually attributed to Mrs. Bryan, have long been regarded as the most elegant of the popular introductions to this pleasing study. . . . I have added some remarks of a practical nature, to render some of the experiments more certain, should the student be inclined to try them. This is a very elegant and a very useful compilation; I have endeavored to contribute nothing to its elegance, but something to its usefulness," and thus in his customary way he interpolates according to his mental promptings. Mrs. Bryan, Caroline and Emily are the three individuals who engage in the dialogue. One may smile at the idea, but much chemical knowledge was derived by all who patiently followed the dialogue. There may have been a similar work, "Conversations on Chemistry," by Mrs. Marcet, for in 1836 Thomas P. Jones, M.D., of Columbia College, later of William and Mary, published "New Conversations on Chemistry," based on the preceding volume, which he said had "acquired and sustained a deservedly high reputation . . . many alterations have been made . . . but still the original platform has remained unchanged." The book performed its task and then passed away. We can recall works, popular and most helpful in our day, which are at this hour rarely mentioned, or if so, we say, "they are out of date," and momentarily forget the wonderful service they rendered. It is because these old books, now in "the sear and yellow of their life," played their part in the growth of our science in this country that this notice of them is taken. The writer will never forget "Barker's Chemistry," which was his first text-book. To-day, the student hears nothing of it. It was the life of earlier chemists; they believed in it, praised it, but it is no more. Let us cherish the memories of all these guides and helps in the promulgation of that science which has won from us our best intellectual endeavors. They had their places, and deserve mention, at least, in reviewing our progress to higher, better, more efficient means of solving Nature's secrets.

The Reverend D. Blair wrote "A Grammar of Chemistry," of which Benjamin Tucker was the American editor. The writer owns the second (1817) and third editions (1819) of this small book. Three editions, printed in this country, were under the editorship of Mr. Tucker. In all of them the frontispiece represents the *Economical Apparatus* of James Woodhouse. The booklet, for such it really is, is most attractive to the present-day student of chemistry.

Under Sulphur appear the following:

"Experiment 1. Sulphur unites with iron when melted. It is used for copying gems.

"Experiment 2. Sulphur, when fused, and slowly cooled, chrystallizes.

"Experiment 3. Sulphur readily combines with the alkalies in the humid way by mere boiling. The muriate of ammonia or sal ammoniac and lime, boiled with sulphur, in a capsule, will combine with the lime, and render it soluble in water.

"Black oxide of manganese is used to produce oxygen gas, or to add a higher degree of acidity to substances already acid, by communicating to them a stronger portion of oxygen or the acidifying principle.

"Experiment:

"Mix an ounce of powdered nitre, with six drachms of the black oxide of manganese and expose them to a red heat in a crucible, until no more oxygen is produced. Then there remains a dark coloured mass, remarkable for the variety of colours it produces when different quantities of hot water are poured on it. Put a small quantity of it into a glass vessel, pour in a little water and the colour will be green. Add more, and the colour becomes blue, a third portion makes it purple, while a few drops of sulphur of lime destroys its colour by robbing it of its oxygen."

More than a hundred experiments are given in the Grammar. It is patterned after the still earlier "Laboratory Guide" of Woodhouse. Chemists of modern times arrogate to themselves the credit of having introduced the laboratory method of instruction now peculiar to our science. A quiet examination of the Grammar will convince anyone that our forefathers were not wide of the correct method. True, their interpretations of phenomena were not always right, but the student, following the course offered in the Grammar, would have been well versed in the chemical methods of his day. He would have had knowledge of many most interesting and important chemical facts. He surely could not have been indicted by the following sentence, contained in the preface:

> "The science of Chemistry has become so popular and fashionable a study, that to be wholly unacquainted with it rather betrays a mortifying ignorance."

Then there was Dr. Isaac S. Haines' "Catechism on Chemistry" (second edition, 1839), based on "the Compendium of lectures by Dr. Hare, and the order and improved nomenclature of that distinguished chemist adhered to as nearly as possible."

A brief volume—"Medical Chemistry"—designed for medical students was printed as early as 1819 by Thomas D. Mitchill, M.D. It is incomplete, but most refreshing, as it is splendidly written.

Different in make-up and different in its purpose from the various text-books in Chemistry published early in 1800 was the "Emporium of the Arts and Sciences." It was inaugurated April, 1812, by John Redman Coxe. It was to be *"a source of practical information in the various branches of scientific research* . . . to convey the rich harvest of *facts,* contained in foreign valuable papers on Chemistry, Mineralogy, etc. . . . original papers of our country of real merit, and of practical tendency will at times be cheerfully received, and promptly communicated to the public." Three volumes appeared under Coxe. They possessed great merit. Even to-day time devoted to the study of the leading articles would be well spent. It may have been ill health or unwillingness to bear up under the editorial strain: whatever the reason, the fourth volume made its appearance under the editorship of Thomas Cooper, Esq., Professor of Chemistry in Dickinson College.

In his prospectus, Cooper promised to make the "Emporium" "a repository of papers on manufactures, that shall be worth preserving. . . . I will not condescend to make this a work of mere amusement, for the purpose of sale." Everywhere Cooper's personality is evident. The first article bears the title Iron. It is most exhaustive. The numerous observations of Cooper are *sui generis*. He also gave a most elaborate presentation of copper and lead. These articles have a present value. At the close of the fifth volume he wrote: "With the present number, the present series of the 'Emporium' closes, for reasons that my publishers will state in the envelope to this number; which would have been out in due time had it not been that the printers were serving their country as volunteers." It was in a personal note in this number that he mentions "Count Rumford first shewed how several vessels of water might be boiled by the steam conveyed from one boiler common to all of them"; that in the fall of 1809 he had made an arrangement of this sort in Doctor Priestley's laboratory and used it in Mr. Joseph Priestley's Distillery.

The "Compendium" of Robert Hare was a classic. It is almost encyclopædic in character.

"Silliman's Chemistry," in two volumes, also played a most important part in the education of chemists.

When the state of our science is remembered these volumes, to which such brief reference has been made, were most creditable.

The current literature, accessible during the same period, was scant. It is difficult to estimate its influence.

While the pioneers whose lives and works have been unrolled before us were active, there was also a simultaneous application of chemical principles in the evolution of chemical industries. Indeed, Philadelphia was eminent in the production of pure chemical and allied products.

As early as 1760 a sample of cotton-seed oil was presented to the American Philosophical Society. In 1796 gas lights were made and exhibited in Arch Street above Eighth, and in the year immediately following (1797) the city possessed six sugar houses, seven powder factories, one aqua-fortis, one sal ammoniac, and one Glauber's salt factory, which supplied the whole Union. It was in that year the American Philosophical Society offered a substantial prize for an essay on American Permanent Dyes.

In 1806 the first ark load of anthracite coal came to this city from Mauch Chunk; and John Harrison was fully established as a manufacturer of oil of vitriol and other chemicals on Green Street above Third Street. His lead chamber was a small one with a capacity of 45,000 pounds or 300 carboys per year. The price of the acid was then 15 cents per pound. He was the first successful manufacturer of oil of vitriol in the United States, having spent two years in Europe acquainting himself with the processes in use there so far as he could gain access to them. He was the founder of the well-known house of Harrison Brothers and Company.

The concentration of sulphuric acid until his time was accomplished in glass vessels. The breakage was great and the expense enormous. Fortunately, there was then a considerable quantity of platinum in the country for which there was no immediate demand. As Eric Bollman had familiarized himself with the working of this metal while in France, he converted some of the unused platinum into a still for John Harrison. This early application of platinum is highly creditable to the sagacity and ingenuity of John Harrison, as its use for that purpose was then only known to a few persons in Europe. Charles Lennig erected extensive lead chambers and concentrated the acid in platinum vessels so arranged as to work constantly and discharge a steady stream of the concentrated acid. Lennig and his associates manufactured in addition soda ash, alum, copperas, aqua-fortis, muriatic acid and all the various preparations of tin employed by dyers.

In 1807 there was in operation a factory for the making of a new article—the patent cloth floor, or summer carpet. These carpets were plain or colored.

The manufacturing of artificially carbonated mineral waters was also introduced. There were many comments by physicians testifying to their healthfulness and purity. "Artificial seltzer, soda, Pyrmont and Ballstown waters were supplied at six cents the glass, and from $2 to $3 per dozen bottles, depending upon the size; and from the fountain to the subscribers at $1.50 per month or $4 per quarter for one glass a day."

Pottery was manufactured similar to that made in Staffordshire, England.

In 1808 the city produced 560 tons of red and white lead. Other paints and colors were made. Various drugs were also prepared.

In 1811 Samuel Wetherill, Jr., received a patent for the washing of white lead, a second for setting beds or stocks in white lead, and still a third, for screening white lead. Painters declared that the Wetherill white lead was equal to the imported article. Twenty-two different colors, bright and durable, in paints were made in our city. Chrome yellow was one of these. It had been prepared from chrome of iron found in Chester County, where it was used as a mineral for turnpikes. Chrome yellow sold for $3 per pound.

In 1811 Philadelphia had a greater variety of manufactures than any State in the Union. There were three oil mills, twenty-eight soap and candle works, fourteen glue factories, seven paper mills, three glass-works, three shot factories, seven morocco factories, seventeen breweries and six drug mills.

The War of 1812 caused such a scarcity of chemicals that many foreigners, who had learned something of chemical manipulations in Europe, were induced to establish factories here; for example, for the manufacture of Prussian blue, Scheele's green and other pigments. One of these foreigners was Kunzi, a Swiss, who worked some time for John Harrison and then with Samuel Wetherill. He and John Farr entered into partnership. They were most prosperous and their undertaking was the foundation for the largest chemical works in America. Under the control of their pupils, Powers and Weightman, the business was immensely extended so that at the present it is one of the largest chemical establishments in the world. One of their early plants was located at the Falls of the Schuylkill, where they made sulphuric acid, nitric acid, hydrochloric acid, Epsom salts, copperas, blue vitriol, alum and alcohol on a very large scale. Their second plant was at Ninth and Parrish Streets, where they prepared sulphate of quinine as well as salts of mercury and codine, citric and tartaric acids with their salts and all the official chemicals of the British and American Pharmacopœias.

In 1813 Joseph Richards founded a white lead factory on a lot on Pine Street between Seventh and Eighth Streets, but in a few years sold it to Mordina and Lewis, who, after repairing the works, made $100,000 on white lead in their first year.

In 1827 this firm began the manufacture of their own acetic acid instead of cider vinegar. In succeeding years they took up the manufacture of linseed oil, red lead, litharge, orange mineral, sugar of lead and paints of various kinds. At the expiration of fifty years the firm name was changed to that of John T. Lewis and Brothers and is now in existence.

In 1816 the New Theatre was illuminated with gas lights, being the first theatre on the continent to be so illuminated.

In 1817 patents were taken out for the manufacture of verdigris and white lead; Joshua Shaw in 1822 invented the percussion lock and cap; in 1828 the Franklin Institute held a remarkable exhibition of chemical products; in 1831 Tucker produced porcelain and china products comparing favorably with the best made in Europe. Further, in this same year there were at least thirty chemical establishments in the United States, with an estimated capital of $1,150,000 and the product was worth $1,000,000 annually; in 1832 the first attempt was made to introduce the use of coke in the manufacture of iron in America; in 1833 specimens of blue broadcloth, called Lafayette blue, dyed with prussiate of potash, were exhibited. In 1839 the manufacture of caoutchouc was greatly improved by Mitchell. In 1850 the value of chemical manufactures, exclusive of white lead, ocher, paint, varnish, zinc, perfumes, cement, pot and pearl ash, amounted to $5,000,000 in the United States.

And now the story of "Chemistry in Old Philadelphia," necessarily imperfect and incomplete in many respects, may close with the words of one, himself a pioneer in another branch of science, but who knew many of the chemists of olden days. His words are a gentle admonition even to us:

"Oh! let it never be said in this City or in this Province (country), so happy in its climate and in its soil, where commerce has long flourished and plenty smiled, that science, the amiable daughter of liberty and sister of opulence, droops her languid head, or follows behind with a slow unequal pace."